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SUBMARINE TORPEDO BOATS.*

PAST, PRESENT AND FUTURE.

By LAWRENCE SPEAR, Naval Constructor, U. S. N.

As the development of the submarine, although fairly continuous, has not been entirely orderly, no sharp line can be drawn between the past and present, and during the merging period the work of contemporaries must be arbitrarily classified. That period is here taken to include the years 1885 to 1891, inclusive.

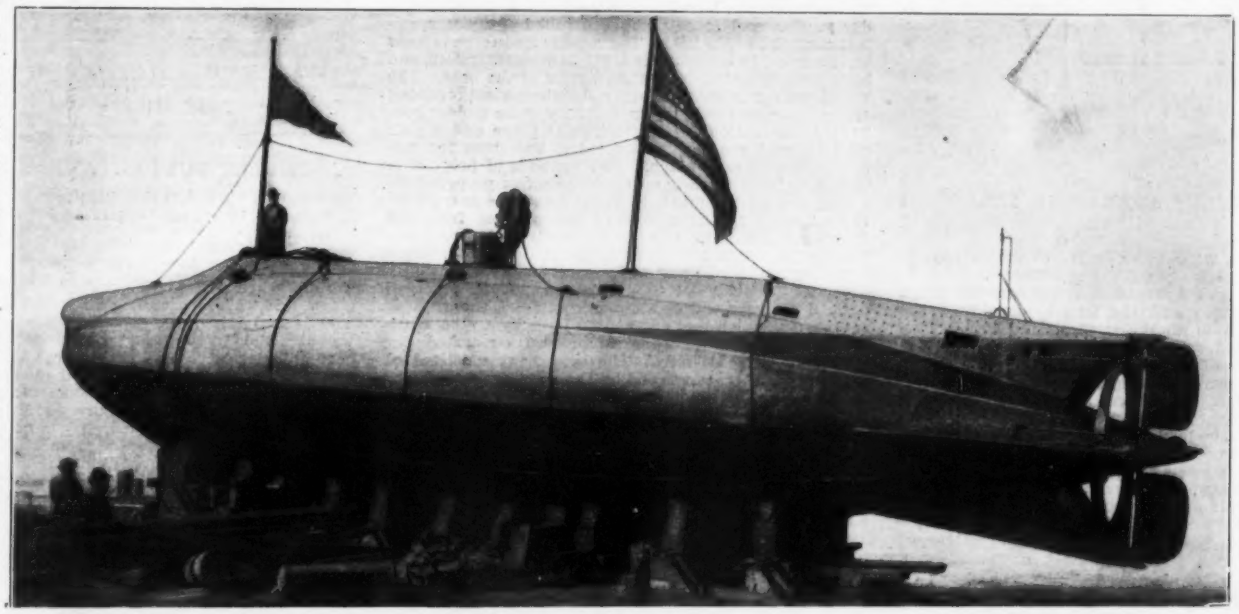
THE PAST.

Up to the seventeenth century man's work under water was apparently confined to experiments with crude forms of the diving bell. In 1624 Cornelius Von Drebbel, a Hollander, invented and built the first real submarine boat, oar propelled and capable of attaining a submergence of 15 feet. No reliable data as to the dimensions and construction of this boat are available, but history tells us that she could carry 12 persons and was rendered habitable for a considerable period of time by the use of "quintessence of air"—probably compressed air or oxygen. The credit for the first boat is frequently given to an Englishman, William Bourne, but there are good reasons for believing that his invention, which antedated Von Drebbel's, really belongs to the diving bell class.

The history of the remainder of the seventeenth century and the greater part of the eighteenth shows but little real progress, for although some of the most important principles were grasped and recorded the practical results achieved were unimportant. During the seventeenth century the center of activity remained on the Continent of Europe, but in the following century the problem received its principal attention in England and America, and from the latter country in 1775 came the first important solution — viz., Bushnell's boat.

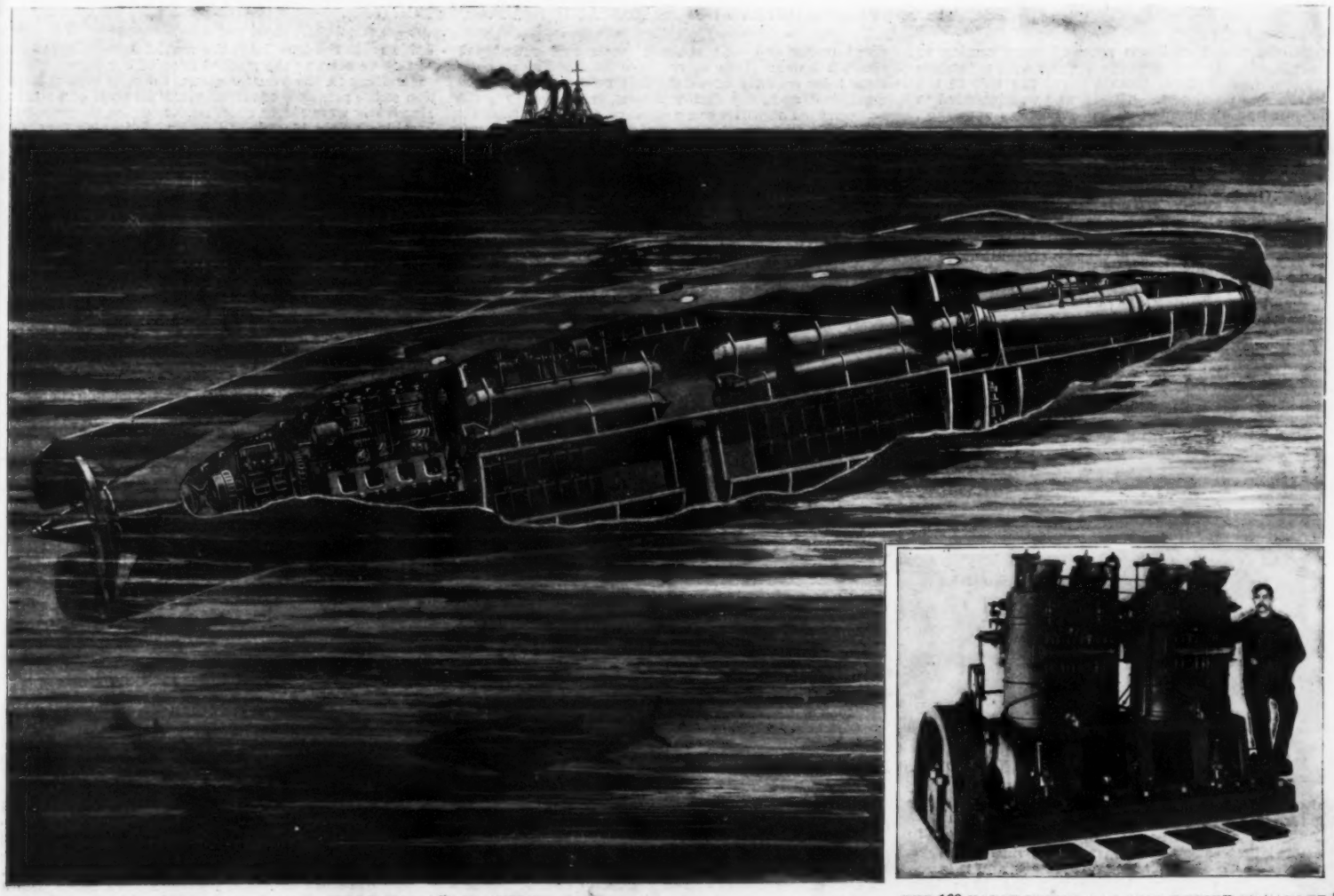
Bushnell's Boat. — Witl

*Abstract of paper read at the New York meeting of the Society of Naval Architects and Marine Engineers.



Length, 63 feet 4 inches. **Diameter,** 11 feet 9 inches. **Displacement Submerged,** 120 tons. **Speed at Surface,** 8 knots. **Speed Submerged,** 7 knots. **Gasoline Tank Capacity,** 850 gallons. **Armament:** One torpedo-expulsion tube; five 45 cm. by 11 feet 8 inches Whitehead torpedoes.

THE SUBMARINE TORPEDO BOAT "ADDER."

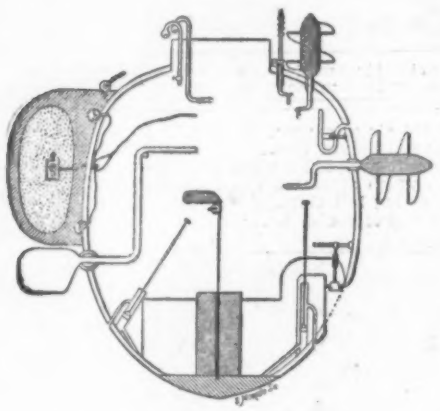


THE "ADDER" IN ACTION.

THE 160-HORSE POWER GASOLINE ENGINE OF "ADDER."

SUBMARINE TORPEDO BOATS.

the appearance of Bushnell's boat—the pioneer torpedo boat, submarine or surface—the art of submarine navigation took a long stride forward and torpedo warfare made its bow, as did also the screw propeller, for although the latter had been invented in England some years previous it had never been practically applied. The drawing given below represents the inboard profile of Bushnell's boat. The information contained in this plan gives a clear idea of the arrangement and relation of parts, so it will only be necessary here to touch on the general features of the design, which, all



BUSHNELL'S SUBMARINE, 1775.

things considered, were well adapted to the purpose in view—viz., the attack upon ships at anchor.

The form, a sort of flattened ellipsoid with the depth exceeding the length and the length exceeding the breadth, was suitable for the strength and stability required. The balance of buoyancy and weight was effected by the water ballast system in the bottom, which also served as a compensating system for weights expended or received. A vertical screw, hand operated, controlled movements in the vertical plane, indicated by a depth gage. The horizontal movement, gained by a bow propeller, was controlled by an ordinary rudder on the stern, the vessel being steered when submerged by compass. The air supply when sealed up was sufficient to sustain for half an hour the one man required to operate the vessel, and was renewed upon coming to the surface by exhaust and supply ducts with automatic operation. Lead ballast, detachable at the will of the operator, was fitted at the bottom, and was intended to be used as an anchor and emergency safety appliance. The armament consisted of a gunpowder torpedo a trifle lighter than the water it displaced. This was carried on the stern of the boat and was intended to be attacked to the hull of the enemy by a vertical detachable screw operated from the interior of the submarine. The release of the mine served to start the clock firing mechanism, which was set to admit of ample time for the submarine to clear the radius of explosion.

The fact is worthy of note that before building this vessel the inventor was required to educate his generation up to the possibility of exploding gunpowder under water and the resulting destruction of floating bodies in the immediate vicinity, so that he was practically the originator of the modern fixed mine as well as of the torpedo boat.

As to the qualities peculiar to the submarine, it will be noted that efficient means were provided for varying the relation of displacement to weight, and it is possible that some reserve buoyancy might have been forced under by the vertical screw. Apparently, however, this was not the designer's intention, nor was the boat so operated, so she must be classed with the later boats designed on the principle of equality of weight and submerged displacement.

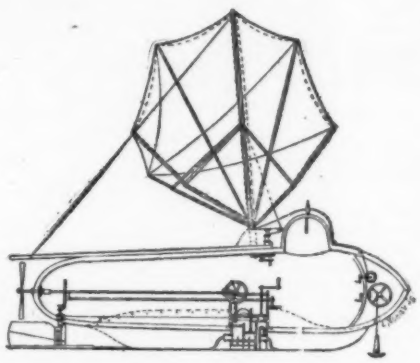
The fact that this boat never succeeded in blowing up an enemy's vessel, though she made three attempts, was due solely to bad luck. The only adequately trained operator fell sick before the opportunity for action presented itself and the initial attempt was made by a half-trained man, who, starting from the New York shore, succeeded in reaching unobserved a 50-gun British ship lying off Governor's Island. He attempted to fix his torpedo without anchoring and failed, as at the first attempt the screw struck an iron rudder hinge pad, and in seeking a new spot he lost the ship and was surprised by daylight before he could renew the attempt. Two subsequent attempts upon British ships occurred in the Hudson River, above New York, and were also disappointments on account of the operator's failure to use his anchor. Eventually lack of encouragement and funds put a stop to the enterprise.

Fulton's Work.—The work thus abandoned by Bushnell was taken up shortly afterward by Robert Fulton, who in 1801, after some years of preliminary work, launched his first submarine, the "Nautilus," into the Seine at Paris. This vessel, an imperfect ellipsoid in form—extreme length about 21 feet, extreme beam about 6 feet—carried a hollow iron keel of a capacity equal to the reserve buoyancy in the light condition, which appears to have been very small. A double cylinder suction and force pump controlled the water ballast carried in this keel. The anchor and torpedo gear were carried in a non-water tight bow compartment and both were operated from the interior of the boat. The vessel was navigated from a hemispherical conning tower fitted on the bow; an ordinary stern rudder controlled the motion in the horizontal plane and a pair of horizontal rudders were fitted at the stern for control in the vertical plane. Two methods of propulsion were provided: 1, a hand operated screw propeller fitted at the stern, and, 2, a single mast and sail so arranged as to permit of folding and stowing from the interior of the boat. The propeller originally fitted consisted of a single convolution, as did Bushnell's. This was later replaced by one of several blades, apparently the first propeller of modern form put to practical use. A compass and depth gage completed the original equipment, which was augmented later by a pipe ventilation system and a crude compressed air system for breathing purposes only. The armament consisted of a gunpowder torpedo towed by the submarine and fired by contact. The accompanying plan gives a clear idea as to the method of operating the torpedo and as to the general arrangement of the vessel. Eventually Fulton and his crew of three men succeeded in remaining under water for a period of 4 hours and 20 minutes without ill effects. The strength of the structure limited the depth of submersion to about 25 feet. The maximum speed under sail was about 2 knots and submerged about 3 knots. This vessel, like Bushnell's, was designed for equality of weight and submerged displacement, and, as in the earlier vessels, this equality could be destroyed at will when necessary. The new features developed were the horizontal rudder, the double motive power, the conning tower and the compressed air system, all permanently established features of the best practice of to-day.

The "Nautilus" was subjected to thorough tests at Paris, Havre, Cherbourg, and Brest, and the results of the tests were embodied in improvements until eventually she gave good promise of efficiency. However, the times were not yet ripe, and although Fulton and his projects created a furor, first in France and afterward in England, he failed to get his system adopted in either country, and eventually returned to the United States, where with Congressional aid his experimental work was continued for some years, culminating in an experimental attack on the brig "Argus," in which the "Argus" was victorious, though at the cost of rendering herself immobile by a system of spars and netting extending to the bottom.

It is supposed that this experimental boat of Fulton's was the one employed in attacks on the British ships off New London in the war of 1812. These attacks forced the British commander to protect himself by the time-honored custom of hiding behind prisoners of war. The complaints and protestations of the relatives and friends of the latter had their desired effect, and the attacks were discontinued.

With the exception of Fulton's work, the first half of the nineteenth century was nearly barren of practical results, but two proposals warrant mention here on account of the prophetic nature of the ideas advanced. The first proposal appeared in a letter from one "M. B." in the "Annals of the Arts and Manufactures" in 1801, describing a submarine designed to work on the bottom. Two pairs of wheels were fitted fore and aft for this purpose, the wheels being driven by cranks, and



ROBERT FULTON. AMERICAN (1797).

The "Nautilus." Length, 21 feet; diameter, 6.5 feet; propulsion by sail while afloat, but by a wheel while submerged; constructed of iron and copper.

assisted when desired by a propeller in the stern; later about 1828, this idea was again proposed by M. Castera. The second important proposal appeared in 1823 and was published in the Annales Maritimes. This proposal contemplated an iron hull of large size, driven by a steam engine on the surface and a gas engine when submerged, and included a telescopic conning tower and submerged projectile tubes, surely sufficiently ambitious and scientific for the period.

Bauer's Boat.—The decade from 1850 to 1860 covers the work of the Bavarian, Wilhelm Bauer, who designed several submarines and built two—the "Plongeur-Marin" in Germany and the "Diable-Marin" in Russia. Aside from the iron hull, the most interesting feature of this vessel was the method adopted for steering and controlling in the vertical plane, the first real application of the principle of the longitudinal shift of weights. Her trials were fairly successful and she succeeded in breaking up the blocade of Kiel by the Danish fleet. On account of the collapse of the stern under water pressure, she was eventually sunk in some 60 feet of water, inventor and crew escaping after an imprisonment of some hours. She has recently been located and raised and is now on exhibition at the naval school at Kiel. In Bauer's second vessel, the "Diable-Marin," longitudinal shifting of weights was supplemented by horizontal rudders, and an air lock for the egress of divers was provided.

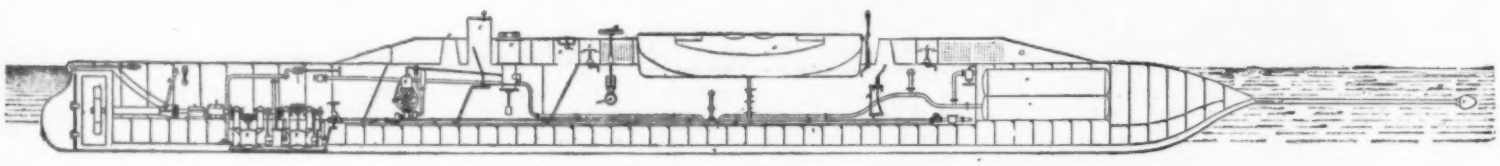
An American contemporary of Bauer's, named Phillips, who experimented on the great lakes with a boat of considerable size, furnished the first example of automatic control in the vertical plane. This was effected by shifting water ballast fore and aft, the control being regulated by an automatic pendulum mechanism.

The proposals of this decade worthy of note here are those of Mariè Davy and Tètar van Elven. The first suggested the electric drive and the second invented an optical tube for taking surface observations while submerged, which was the pioneer of the modern periscope.

The history of the crude American submarines employed in the civil war is well known, and being practically devoid of technical interest need not be recounted here, so that this short review of the submarine torpedo boats of the past may be brought to a close with a brief mention of four different types brought forward between 1860 and 1887—viz., the "Plongeur," of MM. Brun and Bourgeois, the early boats of J. P. Holland, the Nordenfeldt and the Goubet boats.

Brun & Bourgeois.—The first of these, the "Plongeur," designed by Brun & Bourgeois, and launched in 1863, was an experiment on a large scale. The length was 136 feet; the beam, 19 feet, and the depth, 9 feet. She was armed with a spar torpedo and propelled by compressed air, which was also for the first time in history utilized for tank service. The final adjustment between weight and buoyancy was made by altering the latter, two pistons being provided for the purpose. The accompanying view shows the general arrangement of the vessel. The means provided for control in the vertical plane were entirely inadequate for a vessel of her form and dimensions, and her behavior was exceedingly erratic; later her qualities in this respect were improved by horizontal rudders, but her performance was still so uncertain as to condemn the type.

The Holland Boat.—Mr. Holland's work began with a small one-man boat, built in 1877, which may best be described in the inventor's own words: "This boat, 14 feet 6 inches long, 3 feet wide and 2 feet 6 inches in



THE "PLONGEUR." ADMIRAL BOURGEOIS AND BRUN. FRENCH (1863).

TURKISH NORDENFELDT IN DOCK AT CONSTANTINOPLE.

depth, was rectangular in external cross section and spindle shaped inside, excepting in the middle section, which accommodated the operator clad in a diver's suit, and also a 4 horse power petroleum engine in a separate water-tight space. The water ballast was held between the internal and external shells. Two small tanks at the sides of the central compartment held sufficient water to neutralize the reserve buoyancy. When the operator desired to leave the boat, the reserve buoyancy was first neutralized and then the water ballast was forced from the space between the shells into the central compartment around the operator, completely filling it, after which the manhole could be opened without difficulty. Reserve buoyancy was provided for and submersion was obtained by midship rudders."

The action of the submerging apparatus was not satisfactory, and in the next boat, length 31 feet, diameter 6 feet, displacement 17½ tons, finished in 1881, midship rudders were replaced by horizontal stern rudders. The experiments with this boat covered some three years, and the results attained demonstrated the practicability of forcing reserve buoyancy under by power from the propeller, the necessary inclination of the axis of the boat being obtained and controlled by rudder action alone. Continued development along these lines, both here and abroad, has produced the only successful and practical boats now existing.

The Nordenfeldt submarines are principally useful as examples of what to avoid, but merit some attention here, partly on account of the ambitious nature of the designs and the attention they attracted, but principally by reason of the false conclusions drawn by the inventor from his experience, which conclusions variously and ingeniously misstated have served to hamper materially the development of the submarine along proper lines.

Nordenfeldt's attention was directed to the subject by a study of the work of an Englishman named Garret, with whom he later became associated, and the distinguishing feature of Garret's second boat was adopted in all of Nordenfeldt's designs—viz., steam propulsion, both on the surface and submerged; in the latter case steam being drawn from superheated water, partly contained in the boiler used for surface work and partly in special tanks. The accompanying illustrations are of a Nordenfeldt built for the Turkish government. The last Nordenfeldt, No. 4, built in England, sold to the Russian government and lost on the coast of Denmark while making the passage under her own power, had a length of 125 feet, a light displacement of 160 tons and a submerged displacement of 245 tons. With 150 pounds of steam her engines indicated 1,000 horse power. Her estimated speed was 15 knots on the surface in the light condition and 5 knots submerged. In the latter condition the radius of action was expected to be 20 knots. Coal was employed as fuel, and the bunker capacity was sufficient for a radius of action in the light condition of about 1,000 miles at a speed of 8 knots. By employing some of the ballast tanks as bunkers this radius could be more than doubled. She was designed to do her submerged work with about 500 pounds of reserve buoyancy, which was carried under by two steam driven down haul screws, one at the bow and one at the stern. The valves of the down haul engines could be controlled by hand or automatically through a connection with a hydrostatic piston. These screws were relied upon to maintain depth and control in the vertical plane. The only remaining element of novelty was the employment for the first time of the automobile torpedoes, which in the first Nordenfeldt were carried in exterior tubes and in No. 4 in the internal tubes.

The trials of No. 4 in the light condition were satisfactory, but as a submarine boat she was almost a total failure, as the down haul screws proved inadequate to prevent yawing, so that when under water she, like the "Plongeur," took charge and alternately sought the surface and the bottom, duplicating in this respect the behavior of the three previous vessels.

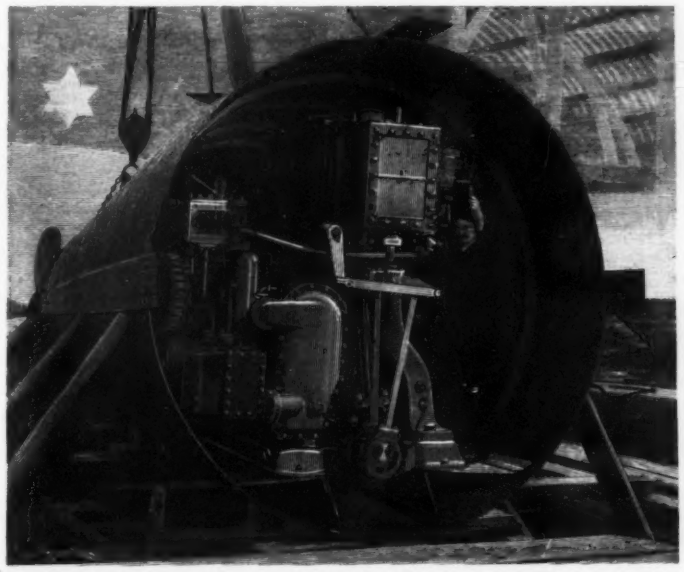
The principal seat of difficulty in all the Nordenfeldt boats was undoubtedly the large free liquid surface in the various tanks, resulting in a shifting center of gravity and a serious decrease of the designed stability. Large tank capacities were a necessary feature of Nordenfeldt's design but the bad features thereof could have been largely reduced by subdivision.

Goubet's Boat.—The last type selected for illustration was designed by M. Goubet in 1885 and began her trials in 1889. An inboard profile and plan view of the vessel with explanatory legend are shown herewith. None of the main features of the design—viz., equality of buoyancy and weight control in the vertical plane by the automatic longitudinal shift of water ballast and a steering propeller—were really novel, but it merits attention as the most successful example of its class. The small experimental boat proved successful on trial, thanks to the care taken with details; note, for instance, the minute subdivision of the ballast tanks. That the type has not been perpetuated is doubtless due to the absence of reserve buoyancy and the unsuitability of the control system for the forms and dimensions required to meet practical conditions.

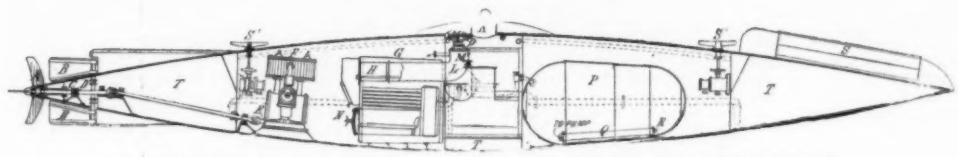
THE PRESENT.

The three leading nations in the construction of the modern submarine are France, with a total of forty-four built, building or provided for; Great Britain, with ten, and the United States, with seven. The subject has been taken up by the other nations, but as their work is still in the experimental stage and but little reliable data is available as to progress it need not be considered here. Great Britain is working along American lines and therefore the present review may be confined to the French and American boats.

France.—The French fleet of modern submarines dates from 1886, when the then Minister of Marine, Admiral Aube, ordered the construction of an experimental boat, the "Gymnote"—length 59 feet, diameter about 6 feet, displacement 30 tons—from the joint de-



CROSS-SECTION OF NORDENFELDT SUBMARINE BOAT FOR THE TURKISH GOVERNMENT.



VERTICAL LONGITUDINAL SECTION OF TURKISH NORDENFELDT.

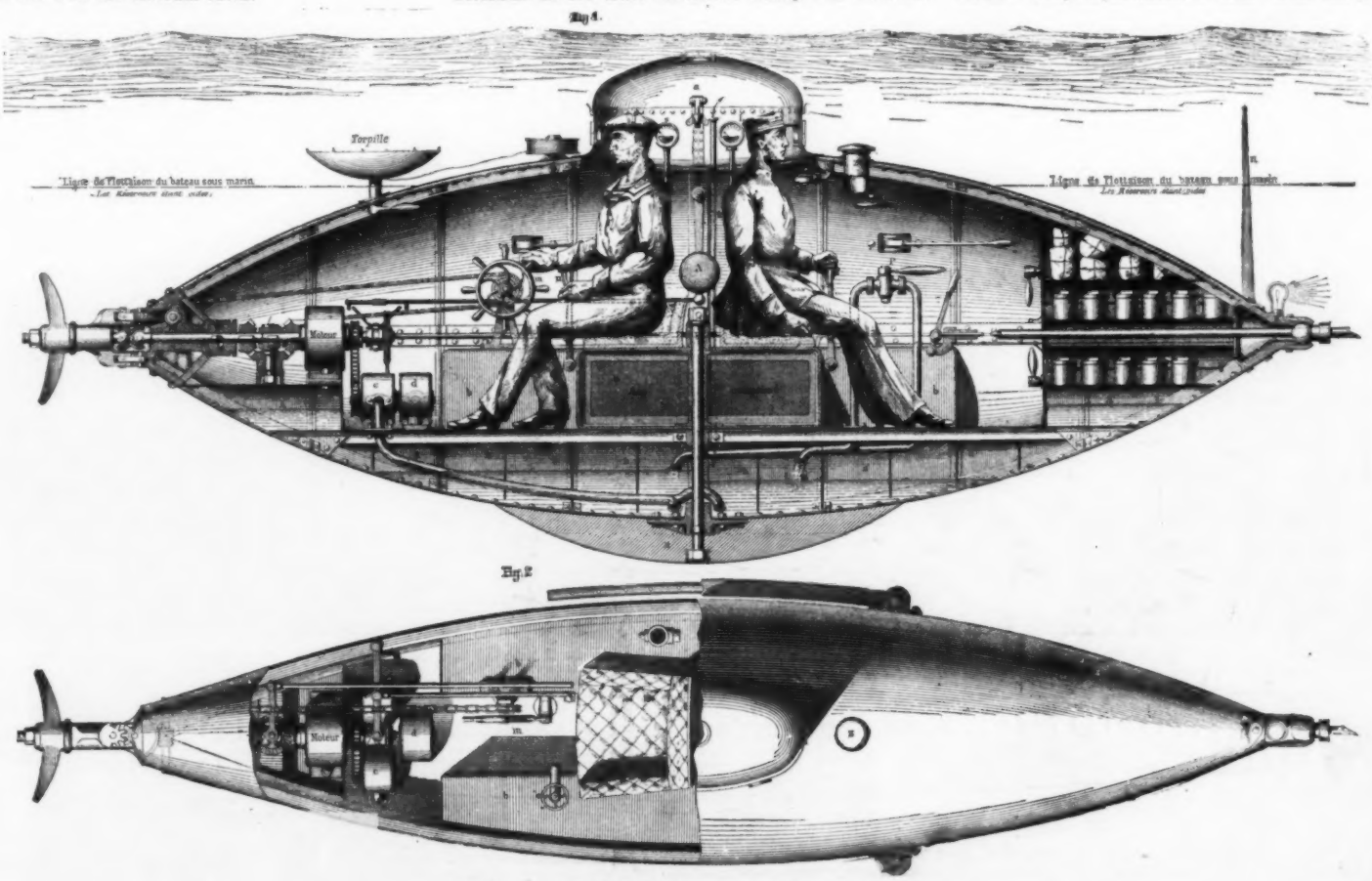


Fig. 1.—Longitudinal Section (Scale 1-10). Fig. 2.—Plan.

GOUBET'S SUBMARINE TORPEDO BOAT.

sign of Dupuy de Lôme and Gustave Zédé. Her spindle-shaped hull was constructed of steel throughout; tank service was obtained from electrically driven pumps and also from a compressed air system, which in addition furnished air for breathing purposes. A telescopic conning tower was provided for observation on the surface and an optical tube for use below. The power installation consisted of a storage battery and a 55 horse power motor driving a single screw. The reserve buoyancy was driven under from the propeller by inclining the axis of the boat, a pair of horizontal rudders being provided for that purpose.

The "Gymnote" Traveling at the Surface.

The trials, beginning in 1888, were very exhaustive and led to the removal of the telescopic tower and a number of other alterations, principally in the propelling and diving gear. Eventually satisfactory results were obtained at a submerged speed said to be 6 knots.

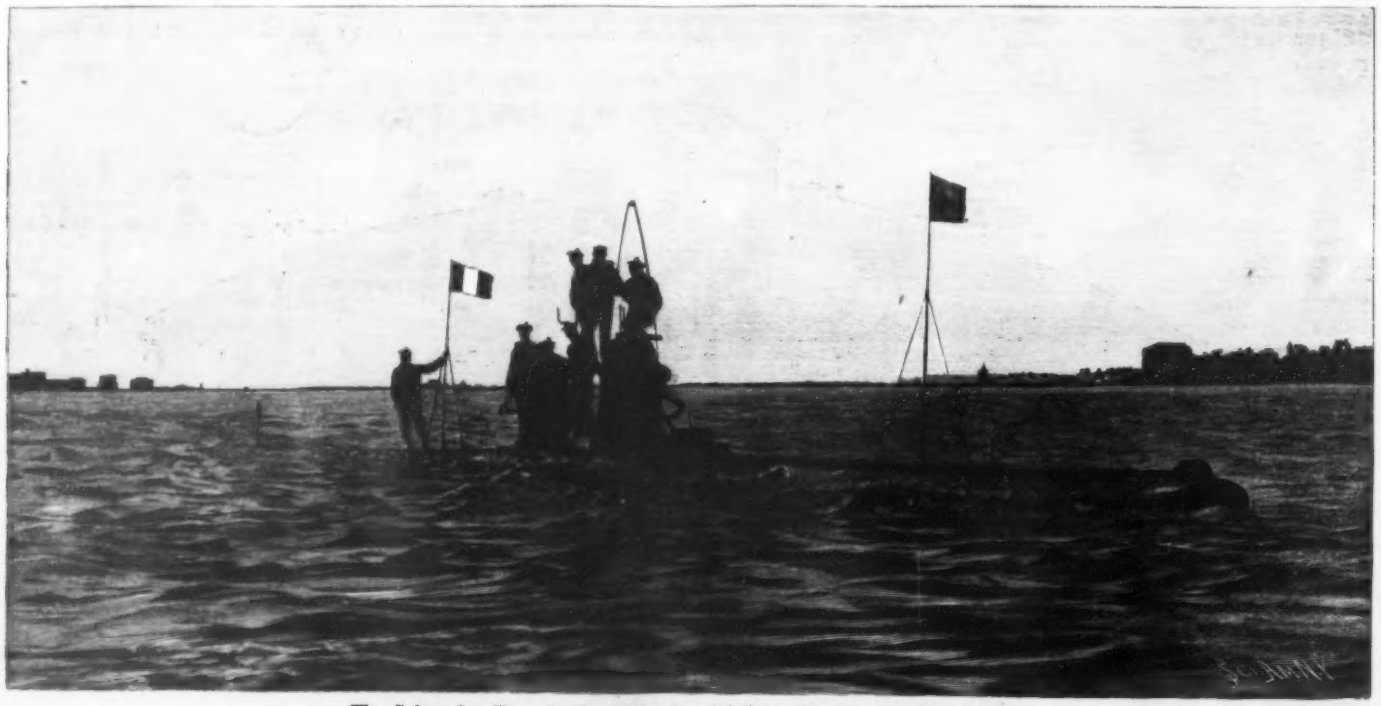
The "Gymnote" was followed by the "Gustave Zédé," ordered in 1890, from the designs of M. Romazzotti and launched in 1891. The design followed closely that of the original "Gymnote," but on a much larger scale, the dimensions being: Length, 159 feet; diameter, 12 feet 4 inches; submerged displacement, 266 tons. The hull was of bronze throughout. She was fitted with a single screw, driven by two 360 horse power motors, fed by a storage battery of 720 Laurent Cély cells. She carried three Whitehead torpedoes and one bow tube.

The step from the "Gymnote" to the "Zédé" proved too large a one and extensive trials and many alterations were necessary before the "Zédé" gave satisfaction. Evidently the designer of the "Zédé" did not take full advantage of the data derived from the "Gymnote," as the alterations in the two cases were along the same lines. The telescopic conning tower was abandoned for a fixed one, the set of horizontal rudders at the stern was supplemented by the addition of a set amidships and a set forward, and the voltage and power were cut in two by the removal of half the cells from the battery. Reports as to her speed in her final form are conflicting, but it is probably about 8 knots. Her behavior in other respects is evidently good, as is shown by her known performances in various maneuvers, noteworthy the torpedoing of the "Martel" in the harbor of Ajaccio during the maneuvers of 1901.

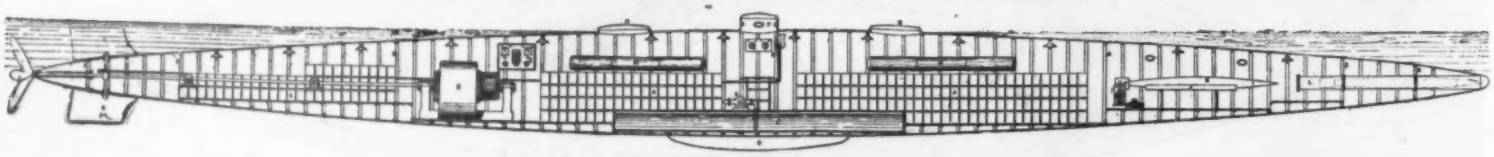
In 1896 the Minister of Marine invited designs for a submarine not exceeding 200 tons displacement, which should carry two torpedoes ready for launching and have a radius of action on the surface of 100 miles at 12 knots, submerged of 10 miles at 8 knots. Of the twenty-eight designs submitted in accordance with this call three were awarded prizes, though the first prize of 10,000 francs was withheld. From among these designs that of M. Laubeuf was later selected for development, and finally took substance in the "Narval," launched in 1899. Her particulars are: Length, 111 feet 6 inches; beam 12 feet 4 inches; displacement, light, 106 tons; submerged, 200 tons. A water tube boiler burning petroleum supplies steam for a 250 horse power triple-expansion engine used for surface propulsion, and for charging air flasks and recharging the storage battery. As to the details of the electric installation little is known except that two motors are employed. The armament consists of four torpedoes in Drzewiecki carriers. The speeds and radii of action are reported to be as follows: Maximum surface speed, 12 knots; radius at that speed, 242 miles; radius at 8 knots, 625 miles; maximum submerged speed, 8 knots; radius at that speed, 25 miles; radius at 5 knots, 70 miles. As to submarine qualities, the design of the "Narval" follows the "Morse," and aside from the double power installation the only item of particular interest is the construction adopted for the hull, which is a development of the system employed in the first Holland boat—viz., complete double bottoms, or rather double skins, the inclosed space being entirely full of water when submerged. The French authorities appear to be well satisfied with the "Narval," except as to the length of time necessary to pass from the light to the diving condition, which is excessive. In later boats of her class that time has been reduced somewhat, but the fault has not been wholly eradicated.

United States.—The modern American submarines all belong in the "submersible" class and date from 1895, when the Navy Department, after competition, selected a Holland design and entered into a contract with the Holland Torpedo Boat Company for the original "Plunger." The history of that vessel is so well known that it will only be necessary here to recall to mind her principal features, which were: Length, 85 feet; diameter, 11 feet 6 inches; light displacement, 140 tons; submerged displacement, 165 tons. A petroleum burning boiler furnished about 1,500 horse power, which was divided between two screws. A storage battery and motor were provided for submerged work. She was designed for 15 knots on the surface and 8 knots submerged, and was fitted with down haul screws to assist her horizontal rudders. This combination was never put to a practical test, as the enormous steam power installed in a very limited space rendered her practically uninhabitable on account of the high temperature developed. Her construction was eventually abandoned and a contract was entered into for a new "Plunger" of a truly modern type.

The "Holland."—While the old "Plunger" was under construction for the government the same company brought out privately the "Holland"—length, 53 feet 10 inches; diameter, 10 feet 3 inches; submerged displacement, 75 tons. She was propelled on the surface by an Otto gasoline engine of 50 horse power, and when submerged by a 50 horse power electric motor fed by a storage battery of 60 cells with a capacity of 1,500 ampere hours at a four-hour rate of discharge. A double commutator was fitted on this motor so that 150 horse power could be safely developed. Her final armament consisted of one bow torpedo tube, one bow pneumatic dynamite gun and three short Whitehead torpedoes. Her surface speeds are 6 knots under the gasoline engine and about 8 knots under the motor, and her submerged speed is 5½ knots under the motor. A single pair of horizontal rudders at the stern, operated by air engines, serve to control her in the vertical plane. These engines, as well as the vertical rudder engines, were arranged for automatic operation when desired, but experience has proven the entire feasibility of brain control and the automatic attachments are seldom, if ever, used. Air compressors and reservoirs furnish air for the steering and diving engines, tank and torpedo service, as well as for breathing purposes. The reserve buoyancy resides in the conning tower, which was originally telescopic, but is now fixed. An inboard profile of the "Holland" is shown herewith and



The Submarine Torpedo Boat "Gustave Zédé" in the Roadstead of Toulon.



Longitudinal Section Through the "Gustave Zédé."

Length, 148 feet; diameter, 10·75 feet; displacement, 260 tons; propulsion by a 750 H. P. electric motor; submersion through the introduction of water and the use of a horizontal rudder.
A, accumulators; *B*, submersion pump; *C*, submersion chamber; *D*, electric motor; *E*, switchboard; *G*, rudders; *H*, steering wheel; *J*, torpedo support; *K*, torpedo; *L*, torpedo tube; *M*, air reservoirs; *P*, conning tower; *R*, hatchways; *S*, water-tight bulkheads.

FRENCH SUBMARINE TORPEDO BOATS.

some photo-lithographic views under various conditions.

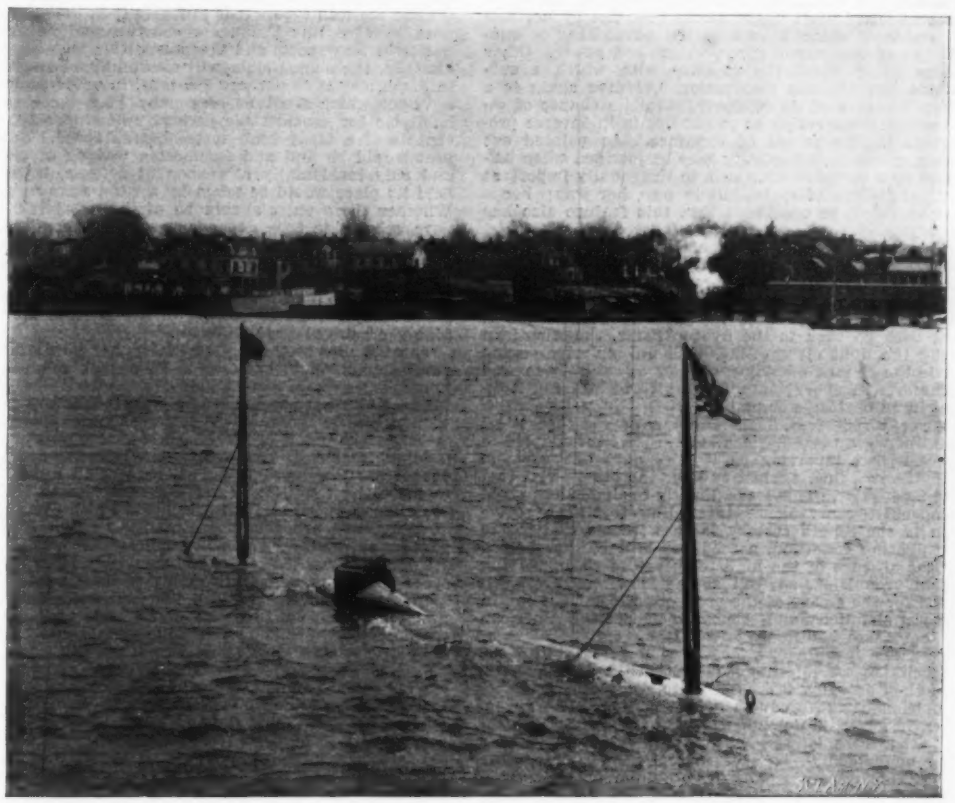
The "Fulton."—In 1901 the same company brought out the "Fulton," built as a trial vessel for the seven government boats, "Adder," "Moccasin," "Porpoise," "Shark," "Grampus," "Pike," and "Plunger," for which contracts were entered into in 1900. The general features of the "Holland's" design have been followed closely in her, but she is larger, roomier, faster, and is simplified and improved as to details. Her particulars are as follows: Length, 63 feet 4 inches; diameter, 11 feet 9 inches; total displacement, 122½ tons. On the surface she is propelled by a 160 horse power four-cylinder Otto gasoline engine, and when submerged by a 70 horse power electric motor fed by a storage battery of 60 cells, with a capacity of 1,900 ampere hours at a four-hour rate of discharge, average potential 110 volts. Pneumatic engines for the steering and diving rudders, the latter with both hand and automatic control, were originally provided. These have since been removed and a simple and efficient hand gear has been substituted therefor. She carries one bow tube and five short Whitehead torpedoes, with water compensation. The engine and motor are so geared up that either can be used to operate the auxiliary machinery, which comprises an air compressor and a powerful rotary pump. The compressed air capacity for torpedo and tank service is 40 cubic feet at 2,000 pounds pressure, suitably reduced for various uses. The change in the relative power of the engine and motor is a large step in advance over the original "Holland," as it enables fair speed on the surface—viz., 6 knots—to be made while charging batteries. Her speed and radii of action are as follows: In the light condition, under the gasoline engine, 400 knots at a speed of 8½ knots and 560 knots at a speed of 6 knots; in the semi-awash condition, under the gasoline engine, 340 knots at a speed of 7 knots; in the submerged condition, under the electric motor, 21 knots at a speed of 7 knots and 35 knots at a speed of 5½ knots, and ready to dive, with the conning tower only showing, she has a maximum radius of 100 knots at a speed of 3 knots.

In November, 1901, this vessel, with a full crew, was submerged at her dock for a period of 15 hours. During this time the only fresh air supply was that furnished by a leaky valve, which allowed the pressure in a flask of 5 cubic feet capacity to run down from 2,000 to 1,900 pounds per square inch. When the vessel was opened up the air was still reasonably sweet and pure and the crew suffered no unpleasant effects. Her habitability under service conditions was tested last spring by a voyage under her own power from New Suffolk, L. I., to the Delaware Breakwater. The first leg of the journey, from New Suffolk to New York, was made through Long Island Sound at an average speed slightly exceeding 8 knots. The second leg, from New York to the Delaware capes, was made under half power at an average speed of 6 knots, except for an hour and a quarter during the journey which was occupied by submerged runs. Her ultimate destination on this trip was Chesapeake Bay, but the voyage was brought to an abrupt termination at the Delaware Breakwater by an explosion of battery gas which had been allowed to accumulate underneath the battery deck. The presence of the gas was due to deterioration of the battery caused by accidental submersion in salt water.

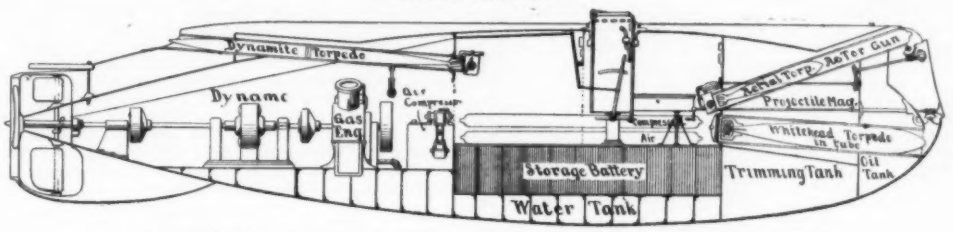
The government boats "Adder," "Moccasin," "Porpoise," "Shark," "Grampus," and "Pike" are practically duplicates of the "Fulton." The accompanying view shows the "Adder" making an official run at the surface. The "Plunger" is the same in dimensions and general arrangement, but differs in some details, the most important of which is the armament, where three long Whitehead torpedoes have been substituted for five short ones.

The "Argonaut."—Before closing the descriptive portion of this paper mention should be made of another modern American submarine—viz., the "Argonaut," brought out by Simon Lake. The "Argonaut" herself does not fall within the scope of this paper, as she was designed for commercial purposes, and is not adapted for torpedo boat work. She is entitled to mention here, however, partly on account of her interesting features, but principally on account of the fact that her inventor is building an experimental boat embodying her principal features, but intended also for torpedo boat work. The approximate dimensions of the "Argonaut" are as follows: Length, 36 feet; diameter, 9 feet; displacement submerged, 60 tons. Her under water work is confined altogether to operations on the bottom. A 30 horse power gasoline engine propels her on the surface by a single screw, and on the bottom by this screw or a pair of driving wheels, or both, as desired. The guide wheel retained by two hollow masts which form ducts for the introduction of air and the expulsion of the products of combustion. As the vessel was intended for submarine surveying, wrecking, etc., a diver's compartment and air lock is made a prominent feature of the design.

The success of this vessel in her field has led the inventor to place on the stocks a new and larger vessel



THE HOLLAND BOAT AT HIGH SPEED WITH CONNING TOWER ABOVE SURFACE FOR OBSERVATION.



LONGITUDINAL SECTION THROUGH HOLLAND SUBMARINE BOAT.

serves as a rudder, both on the surface and submerged. In common with other submarines, she has a water ballast, compressed air and electric light system, which present no novel features except as to the bow searchlight for examination of the bottom. She is submerged by down haul weights of 1,000 pounds, attached to suitable windlass mechanism by which any amount of reserve buoyancy not exceeding the down haul weights may be hauled under. The water ballast system enables the relation between the down haul weights and the reserve buoyancy to be altered at will, so that the virtual weight on the bottom may be controlled. Communication with the surface is always in which it is intended to combine the bottom working features of the "Argonaut" with the necessary properties for operation between the surface and the bottom. This vessel is to be fitted up with a storage battery and motor, so that communication with the surface need not be retained. The apparatus for controlling between the surface and bottom will consist of inclining planes fore and aft, termed by the inventor "hydroplanes." The design contemplates great stability, the intention being to maneuver on an even keel, the hydroplanes serving simply to give a vertical thrust, but no turning moment about the center of gravity. At the time of writing this vessel has not been launched, so no data are available as to the efficiency of the design, except in so far as it duplicates the "Argonaut."

THE SUBMARINE "ADDER" MAKING HER OFFICIAL SURFACE RUN.

THE FUTURE.

Before attempting to foreshadow the future of submarine torpedo boat construction, it will be desirable to examine in a little more detail the more important features of the modern types, as such examination, though necessarily brief, should enable us to judge roughly both as to the propriety and possibility of future development along the present lines.

Confining ourselves at present to the submersible type, we note that the French and American designs, though independently worked out, are identical as to general principles and close to each other in the main features of design, the difference in the aims of the designers being taken into account. The distinguishing features as submarines are, first, reserve buoyancy, and second, control in the vertical plane by rudder action only.

Reserve Buoyancy.—The presence of reserve buoyancy undoubtedly increases the difficulty of securing complete and satisfactory control in the vertical plane, as no matter where located it introduces an upward force which requires balancing, and it may, in addition, introduce a turning moment about the center of gravity which also requires balancing. Its advantages, however, entirely justify its presence, since it not only serves as an instantly available element of safety in an emergency, but also permits the submarine to maintain the awash condition, whether under way or not, without change of ballast or direct expenditure of power. In this condition, ready to dive instantly, presenting only the conning tower as a target, and herself commanding a complete view of the horizon, the submarine will do a great part of her work, even in the event of the perfection of observation apparatus for use when submerged. It is safe to conclude, then, that this feature has been permanently adopted.

Control.—The second characteristic, viz., control in

the vertical plane by rudder action only, is also fully justified by tactical and construction reasons. It is obvious that a change in depth can be effected in the least time and by the least expenditure of energy, if the vessel be moved in the direction of least resistance; in other words, if she is steered up and down inclines by altering the angle of her longitudinal axis to the horizon. In order to be effective the turning moment used must be of considerable magnitude and under the most sensitive control, conditions best met by horizontal rudders, which have also the advantages of simplicity and economy of space, weight and power. Other things being equal the rapidity with which a submarine can rise for observation and dive again is a direct measure of its efficiency, since its chance of escape from observation or projectiles is in inverse proportion to the period of exposure. As pointed out below, a loss in this quality may be justified when balanced by a corresponding gain in the equally important tactical feature of speed, but in no other way; hence it may fairly be concluded that this feature also has come to stay.

The correspondence between the French and American designs extends also in a general way to the most important construction feature—viz., the power plant. For submerged work both have adopted the electric drive, and for surface work and recharging batteries, etc., both go back to the hydrocarbons, the American using the light oil gasoline, with an explosive engine while the French employ a heavier oil, petroleum, and transform its energy into steam instead of using it direct in an explosive engine.

American System Best.—From a purely theoretical point of view, the American system is better adapted to the purpose, involving as it does only one variable weight—viz., fuel, against two for the other—viz., fuel and feed water. This leads directly to simple and rapid compensating arrangements tending toward a reduction in the time necessary to pass from a cruising to the fighting condition, a tendency still further helped by the absence of the high temperature accompanying steam propulsion, as well as the slow working apparatus for the escape of the products of combustion. In general simplicity and economy of space the American system offers additional advantages. On the score of safety the advantage, if any, lies at present with the French. A less volatile oil is used in the first instance, and it is probably less difficult to secure the complete expulsion of the products of combustion. The advantage, however, is not important as the danger element in either case is well within permissible limits and will undoubtedly be still further reduced in future boats employing the American system by the use of heavier oils and the perfection of the apparatus for disposing of the products of combustion. The principal advantage of steam propulsion lies in the fact that the designer can avail himself of very complete data based on experience, whereas since the marine oil engine of the power now required is practically new in the field, the designer is hampered by lack of reliable data. Ultimately, however, the oil engine will probably displace the steam engine, since the development of the former offers the possibility of a single motive power for all conditions, which will be reasonably efficient in the submerged condition. Modern chemistry is already in a fair way to provide the materials for supplying the necessary oxygen in such form as to meet the conditions imposed in a submarine. In the meantime the growing field of the oil engine, both afloat and ashore, will supply the experience necessary for the development of the largest powers apt to be used in the submarine.

Electric Drive.—The remaining important feature common to both designs is the employment of the electric drive for submerged work. The storage battery and motor are admirable in some respects, but exceedingly inadequate in others, the principal objection being the well-known one of excessive weight and space in proportion to the power developed. When it is stated that a weight of 370 pounds per horse power hour is a fair average for a suitable installation, it is readily seen that there is much room for improvement. Another disadvantage of the battery lies in the care and attention necessary for its safe operation after sensible deterioration has set in. The difficulty which takes the shape of abnormal behavior with respect to "gassing" may, under certain conditions, result in an explosion, such as took place on the "Fulton" last spring, and more recently on the "Holland." Fortunately, however, this condition is not inevitable, and is susceptible of control when it does occur.

There is no particular quarrel with the motor, except as to the difficulty in fitting it with a suitable propeller, and the battery bids fair to develop faster in the future than in the past, on account of the increasing demand for a light, compact battery for automobile use. Its continued use may thus be expected until the appearance in practical form of a development of a heat engine similar to that hinted at above.

The principal difference between the French and American designs lies in the choice made of dimensions and proportions, which appears to be the direct result of different ideas as to the relative values of speed and maneuvering qualities. To attain the high surface speed desired the French designers have been forced to adopt a considerable displacement, great length in proportion to beam, the double hull with large tank capacity, and incidentally the steam engine and multiple rudders. As compared with the Holland boats, the increase in surface speed is gained by a sacrifice of efficiency in three directions: 1, As to simplicity; 2, as to the length of time necessary to pass from a cruising to the diving condition, and, 3, as to the necessary period of exposure for conning tower observations. No exact data are available as to the minimum observation period required by the French boats, but their extensive use of the periscope indicates a relative inferiority in this respect. In shallow water at least this result would naturally follow from the dimensions and form adopted, as it is probable that the rudders are then used to produce not only a turning moment, but also a vertical thrust.

While the limit of surface speed for a given displacement has not yet been reached for either type, further material advances are most apt to be made by further increases in displacement. The limit to this process is not set by construction reasons, but by the probable use of the type, which for any one country is fixed by its geographical location and the nature of its coast and harbors. For instance, a submersible of the "Narval" type and dimensions is for France not only a defensive, but an offensive weapon, and the partial sacrifice of submarine qualities in the design is warranted by the possibilities for offensive use. The same boat transferred to America would become purely defensive and would not be so well adapted to the conditions here as is the American type. It is probable then that in countries situated like France, where the possible enemy possesses large ports and arsenals within easy striking distance, the submersible will eventually be increased in displacement to perhaps 300 tons, in order to obtain a vessel which shall be seaworthy in a large sense, habitable for considerable periods, self-supporting and capable of a fairly high sustained sea speed. Such a boat would be first and foremost a weapon of offense and only incidentally a weapon of defense, in which field its place would be taken by several smaller units. Whether these units should be of the submersible or pure submarine type depends upon the extent of the coast, the number of harbors, the internal water ways and the condition of the fixed defenses. As noted above, France has adopted for this purpose the submarine of the Perle type, a course which is probably justified by the small number of her harbors and her highly organized fixed defenses.

Turning now to the United States, her location with respect to possible enemies is such that there is no immediate prospect of the development of the large submersible into an offensive weapon; still the extent of her coasts, the number of her harbors and rudimentary character of her fixed defenses render this type preferable to the pure submarine for defensive purposes. The development of the best all round boat to meet the conditions is likely here also to lead to some increase in total displacement, which eventually, however, will probably not exceed 200 tons. As compared with the larger offensive submersible, such a vessel would be less seaworthy and would have less surface speed, better maneuvering qualities, and greater submerged endurance. The pure submarine would thus at first glance appear to be an undesirable type for the conditions prevailing in the United States, but this is only true so long as the sole aim is torpedo work. As a matter of fact, however, the usefulness of the submarine is not confined to this one function, as it affords to-day the best known means for the destruction of mine fields and cables and the reconnoitering of fortified harbors. The objective being far removed, it is essential that the dimensions and weight of this type of vessel be kept at the lowest limit in order to admit of transportation by battleships, armored cruisers and the larger class of scouts. In such a vessel some armament would be desirable for attack upon stationary shipping, dry docks, etc., but this feature should be subordinated to the features necessary for efficient bottom work. By taking full advantage of the latest developments in diving apparatus all the essential features, including efficient signaling apparatus, could today be combined in a maximum length of 35 feet and a maximum displacement of 25 tons. This appears to be the only possible guise in which the pure submarine may play an offensive rôle, and even here, in the author's opinion, means for recharging batteries are desirable and justifiable, as scout work might require a considerable radius of action.

CONCLUSION.

To sum up, it appears that the submarine boats of the near future will naturally divide themselves into four types and two main groups, to conform to the different conditions in the different maritime countries. Group 1 would be suitable for many of the European countries, and would include the large offensive submersible, self-supporting, with auxiliary bottom working features, and the small defensive submarine for torpedo work only. Group 2, suitable for the United States and similarly situated countries, would include the small offensive ground working submarine or submersible (with auxiliary armament) and the medium sized defensive submersible for torpedo work only. It appears, further, that the submarine qualities of the modern boats are based on sound principles, and that the future development of the four different types within the limiting displacements of each must be along the present lines, and in the direction of improvement in the tactical qualities of speed and practical radius of action. As pointed out above, improvements in these respects are largely dependent upon the general improvement of the power installations, and as compared with the corresponding feature in the main objective, the battleship, the improvement in the submarine bids fair to be the more rapid.

THE NAVAL WAR GAME "WAR."—VII.*

By FRED T. JANE.

AFTER THE BATTLE OF MANILA.

AFTER the victory of Manila the German fleet proceeded to blockade the bay, and a claim was put in for the capture of the American base. This the umpires disallowed.

The entire German military force was then landed, and a number of shore operations followed. To follow these in detail would be tedious, and it suffices to say that the net result was a falling back of the American army upon Cavite, which the Germans invested.

The working of the game about here was not eminently satisfactory to all those engaged in it, for reasons to be found below. The umpires deducted ten per cent of the German force for "sickness due to the effect of climate on troops worn out by a long sea voyage." This decision was hotly contested by the German players, as also was a second decision in which the umpires refused to allow the Germans any information as to the whereabouts of the American North Atlantic squadron, last heard of as steaming south off Rio de Janeiro. The reasons for this refusal were as follows:

The American players put in that the North Atlantic squadron after passing Rio Janeiro, spread out, so that if sighted by any merchant vessels, one American warship and not an American fleet would be reported. In addition to this the "Maine" and "Missouri" were ordered to steam back toward Key West until they had been sighted thus by merchant vessels. This accomplished, they were to return again and pick up the rest of the squadron off the Horn.

The whole American situation was at this time precarious, for the second Kiel fleet was displaying considerable activity. Leaving Kiel, it steamed north, a formidable enough squadron consisting of the "Wettin," "Mecklenburg" (lacking her heavy guns), "Brandenburg," "Woerth," "Weissemburg," "Kurfurst Friedrich Wilhelm," "Baden," "Sachsen," "Würtemburg," "Bayern," "Aegir," "Odin," "Heimdall," "Hildebrand," "Hagen," the new armored cruiser "Prinz Adalbert," the old cruisers, "Irene" and "Prinzess Wilhelm," with sixteen destroyers and six 25-knot torpedo boats. With it were several colliers. Ostensibly this fleet, of practically every available German ship remaining, was bound for the North American coast. The whole move constituted a very clever ruse, in the following fashion:

A trifling calculation showed that by far the greater number of these ships carried too little coal to cross the Atlantic, so the United States North Atlantic squadron proceeded toward the Philippines without regard to the new menace. Presently the (from the U. S. standpoint) expected happened, and the second Kiel fleet was heard of as having gone into various bays on the Norwegian coast. It was then ascertained that many ships were going back singly and more or less secretly to Kiel. The American side chuckled and went on chuckling till they heard that the "Wettin," "Mecklenburg," "Brandenburg," "Woerth," "Weissemburg," "Kurfurst Friedrich Wilhelm," "Prinz Adalbert," "Irene," and "Prinzess Wilhelm," accompanied by many colliers and with from twelve to fourteen destroyers in tow, were in mid-Atlantic. The ruse, in fine, was eminently successful.

We may here leave the second Kiel fleet for a time and return to events in the Pacific.

Off Manila, presently isolated and unable to cable, the Germans maintained a desultory blockade. Three of the "Kaiser" class ("Kaiser Friedrich III.," "Wilhelm II.," and "Wilhelm der Grosse") had gone to Kiao Chau to refit; the "Bismarck" also had gone thither for the same purpose.

All this while the U. S. S. "Ohio" had been completing for sea at San Francisco. When ready she ran south, intending to meet the North Atlantic squadron at Cape Horn. The Germans, having received information of her departure, dispatched the "Wittelsbach" and "Zaehringen" to intercept her.

This reduced the blockaders to two ships of the "Kaiser" class and the "Hertha" and "Hansa." Learning this, the "Albany" ran the blockade and got away south without injury. The "Hertha" and "Hansa" chased her a little way, but were soon left behind.

The next night the "Brooklyn" essayed the same thing, but blundering into one of the battleships, was sunk by a short range fire.

The methods by which this blockade running was worked may be of interest. The blockaders were made to furnish a chart and full notes of their positions for the whole period. All movements and positions that could be observed from the shore were communicated to the Americans, and the course of any blockade runner compared with the positions of the blockaders at any given time. If this brought hostile ships within sighting distance, subsequent incidents were worked out by whatever orders had been issued by either side against such a contingency.

On the night that the Albany ran out, the battleships were some ten miles out, due west, the "Hertha" and "Hansa" being well south, the latter close inshore. Passing between these two ships, the "Albany" was sighted by the "Hertha," which fired rockets. Bearing inshore to avoid the "Hertha," the "Albany" came within 2,500 yards of the "Hansa," and shots were exchanged. These were ineffectual, and her high speed enabled the "Albany" to escape.

The "Brooklyn" the next night took an identical course, but when bending inshore from the "Hertha," sighted the "Hansa" without being seen. (These questions of sighting, being pure chance, were settled by dice throws.)

Seeing the "Hansa," she bore round due west. The player who acted as captain of the "Hertha" also sighted the "Hansa," and opened fire on her in mistake for the "Brooklyn." She then got out searchlights, and discovering her mistake, fired signal rockets. The battleships, acting on the prearranged orders, steamed in toward the lights, and it was umpired that, silhouetted against these lights, the "Brooklyn" would be seen before seeing the Germans.

One battleship opened on the American cruiser at once, the other bore round southwest, and this ship—the "Kaiser Barbarossa"—it was that sank the "Brooklyn."

The "Albany," once clear, went on south and fell in with the U. S. North Atlantic squadron without incident. This fleet, lacking scouts, found her extremely useful.

(To be continued.)

* Prepared especially for the SCIENTIFIC AMERICAN by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the SCIENTIFIC AMERICAN SUPPLEMENT of December 20, 1902.

ATMOSPHERIC ELECTRICITY AND EARTH CURRENTS.

By E. O. WALKER, C. I. E.

ON the Nilgiri Hills, in India, Michie Smith found, on the edge of a dissolving mist, the potential to be lower than the normal, and, on the edge of a condensing mist, higher. On Ben Nevis Dickson noticed that when the summit was clear a current came up the mountain, and that the reverse was the case when the summit was enveloped in mist. Similarly, on Vesuvius, the observations of Palmieri go to show that during a fall of rain or snow the current is, in direction, downward, and when the mountain is clear, in most instances the opposite occurs.

Beyond the probability that vapor movements alter the atmospheric potential, there are other facts which ought to be considered in this relation. Kelvin has

shown that electrification of air is diminished by raising the temperature; so also has Warburg, and he thinks that the electrification is probably due to condensed water particles. He adds that air without dust is not electrified. That assertion has not been borne out by others; at the same time there is no doubt that dust profoundly modifies the electrical state. Palmieri finds that when the volcano is active the direction of current is downward. This is contrary to what occurs in a clear sky. Elster and Geitel assert that on mountain tops the density of the negative charge of the earth is greatest, but that there is a preponderance of positively electrified particles in the air. They add that in cloudy weather the condenser action of the clouds alters the conditions. In a broad sense, Schuster found in Switzerland, at high elevations, a high degree of positive electrification in the air, and a lowering of the same when the current blew off a glacier. Perhaps it may be said that cold makes vapor negative and heat makes it positive, and it is the movement of vapor, no doubt, which renders the distribution of potential below 1,000 meters in height very obscure. Chauveau, in France, finds that a disturbing influence, due to vapor, and strongest during summer, complicates the diurnal variations of the electric potential, which would otherwise have a simple oscillation.

Elster and Geitel suppose that the atmosphere contains an equal number of plus and minus ions; that fog destroys the mobility of the ions by attaching them to water drops; in the earth's electrostatic field the free ions undergo a partial separation. The positive ions round the mountain tops produce a discharge of negative electricity from them. An unimpeded acquisition of negative electricity takes place on the earth's surface wherever the negative ions penetrate below, as they practically do under the foliage of a forest. So the earth gets its negative charge. Cloud stops the ions and accumulates electricity, and disruption follows. Elster and Geitel appear to think with Lenard that the ionization of the air is caused by ultra violet light, more particularly in the highest strata of the atmosphere, which would account for conductivity in those regions and for luminous phenomena. A similar supposition is entertained by Ebert and Hoffmann. A body suspended above the surface of liquid air was found to acquire a strong negative charge, due to friction of minute particles of very cold ice in the vapor. The ice was positive to the body, especially so when cold and dry. Generalizing from this experiment, they attribute the electric effects of polar snow storms to this cause, and conjecture that, high up, where ice crystals are in suspension, the atmospheric electrification may be partly occasioned by friction between such crystals and cosmic dust, and that solar ionization shares in its production.

Arrhenius, on the other hand, thinks that auroræ are cathode ray phenomena. Near the poles, where the magnetic lines are vertical, these rays can penetrate more deeply into the atmosphere. Electric discharges, occurring on the sun, produce cathode and Röntgen rays. Cosmical particles projected by the sun, carry charges to other bodies; these are arrested in the high strata of the atmosphere, and produce cathode rays when discharged by ultra-violet light.

Regarding the sign of electrification in the upper regions, Elster and Geitel, by balloon experiments, have ascertained that negative discharge takes place quicker than positive up to 3,000 meters, and above that height the rate is more nearly equal. In dry, clear air the rate is nearly as great as near the earth, but in damp air the discharge is much reduced.

It is possible that difference in the potential gradient over land and over sea is productive of electric currents in the air and on the earth's surface. A large eddy, produced by the sun north of its path round the earth and another south, would account for the horizontal movement of the needle which is daily recorded in magnetic observatories, and would also be productive of the earth currents witnessed in telegraph lines and cables. These two phenomena are intimately connected, and it is hardly necessary to cite facts in support of such an assertion. But one not generally known may be quoted. From a number of observations made of the earth current from Belgaum to Vingorla in India, some 20 years ago, it was found on quiet days that the rate of change of the force producing the current, whatever it was, varied from ½ foot to 22 feet per hour.

If the daily variation in declination be due to a slight shifting of the magnetic axis of the earth under the sun's action, the north magnetic pole would, for India, be displaced to the eastward about 739 feet in seven hours, and then slowly return to the normal. This movement is at the rate of 106 feet per hour, and, within the limits of observation errors, the approximation in slowness of change of force in the two cases is very striking.

Adverting to the possible effect of differences in potential gradient in the atmosphere in production of currents, the figures given by several observers render this surmise significant. At Delhi the gradient is 127 volts (Mache). At Luxor, in Egypt, Exner found the maximum to be 128 volts per meter, at Bombay 64 volts, and in Ceylon 57 volts. At Jeur, in the Deccan, Ludwig found 150 volts, and made the interesting observation that the potential gradient fell from 150 to 120 as totality of the eclipse of 1898 was approaching, and went on falling to 89 volts for 30 minutes after it was over. He remarks that the potential gradient clearly does not depend primarily upon the temperature. Exner supposes that air-borne dust and vapor cause maxima and minima of potential gradient. Braun's theory that it falls with rising temperature is inconsistent with the above facts.

It was with these thoughts in mind that observations were undertaken by the writer in Ceylon. Earth currents in the telegraph lines are not present to any great degree, but the manifestations were similar to those in the south of India. Between Paumben and Manaar, where the shores are low and sandy, and the two stations connected by 16 miles of overhead wire and 35 miles of cable, no difference of potential was observed greater than ¼-volt. The atmospheric conditions of the two places seem to be too much alike to permit of any difference electrically, and the gulf waters, of considerable extent on both sides, assist to produce an electrical level. Again, with regard to any possible effect by the earth's magnetic field, as no part of the line is elevated, no such effect could be predicted, nor did it come to light. Between Colombo and Kandy the case is different. The former is on the shore and at the sea level, and the latter on the hills at an elevation of 1,700 feet, distant about 70 miles east of Colombo. The end of the line, however, at Kandy is among thick and tall trees, and the town itself nestles among high hills; the Colombo end is very near the sea, but surrounded by high buildings, so that in both places effects due to atmospheric electricity would naturally be somewhat obscured. Observations of the earth current were taken between 7 and 9 A. M. It flowed generally from Kandy to Colombo, and the maximum was observed on a fine and sunny day. It would seem to have been due to a difference of potential between the two ends of the line of 1.5 volt. This was at 8:19 A. M., but, compared with other days and with different states of the sky, this difference of potential was not found to be the same. Once, when the sky was overcast at Colombo and clear at Kandy, the current flowed from the former to the latter, and showed only 0.5 volt. Between Belgaum and Vingorla, in India, where the conditions are analogous, the average maximum difference of potential was found to be 1.5 volt, and the current was down the line, from the mountain to the sea shore, in the mornings.

These figures are too high to be attributable to thermal effects at junctions of earth plates with the soil, or to electro-chemical effects at the plates, and seem to be due to an influence external to the circuit of the wire, earth plates, and intervening earth. For instance, a small model was constructed with earth plates and mold similar to that actually occurring in the localities concerned, and the temperatures at the respective ends were artificially reproduced. The highest E. M. F. obtained was 0.03 volt. Again, in view to ascertain whether the different states of the iron earths were contributing to errors, a galvanized and a plain iron earth buried a little distance apart were tested and the E. M. F. obtained was 0.1 volt. Lastly, to prevent polarization due to signaling currents from affecting the measurements, earth connections quite distinct from the telegraph office earths were employed during the experiments.

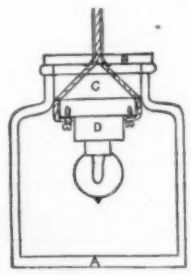
In view to elucidate the cause of the earth current, observations were instituted at Colombo with a Kelvin quadrant electrometer kindly lent by the Technical College. The collector was a tinned disk suspended at 67 feet from the ground, on the roof of the building, and 13 feet above the latter. The lead was well insulated, and every part of the circuit insulated by blocks of paraffin where any contacts with the building were likely. The variations in the air potential were irregular. Generally, there was a slight increase of positive electricity when a gust of wind occurred. The direction of the wind at this season was south-west or west-south-west. On two occasions about 8 A. M., when heavy clouds prevailed and a light or gusty wind, sudden negative deflections due to 5 and 10 volts were respectively noticed. In fine weather, again, there have been sudden variations of 5 volts.

At Kandy, where some observations were also made, very slight variation was observed, hardly to the extent of 1 volt. The collector was also above the roof of the building. Once, in heavy rain and fitful wind, there was an increase of positive electrification of 10 volts. It would seem on the whole, in the early morning at Kandy that the air potential is more positive than that of Colombo, and has less variation at the season of observation, which was during the prevalence of the southwest monsoon. It is not impossible that on the mountains, the effect of solar radiation being greater in the less dense atmosphere, the ultra-violet rays may modify the earth's negative charge to a greater extent than at low elevations, and produce the result that is manifested in the earth current. As these rays must fall in different phases at different places there would also be present the conditions favorable to extensive electrical eddies in the air.—Electrician.

FISHING BY ELECTRIC LIGHT.

AN electric-light equipment that will add to the interest of an evening's fishing, as well as to the length of the resulting string of fish, is described by a correspondent of Amateur Work. He says:

"The necessary materials are: a small incandescent



FISHING BY ELECTRIC LIGHT.

electric globe and porcelain base of about three-candle power and three volts; a dry battery for same, of the kind used in bicycle or night lamps; several yards of two-way flexible covered wire of small diameter, some rubber tubing to cover the flexible wire, a glass bottle with large mouth, and rubber cement.

"The neck of the bottle should be large enough to easily admit the porcelain base. Cut a circular piece of wood, *B*, from a cigar-box, large enough to cover the top of the bottle, and in the center bore a hole to admit the rubber tubing with a tight fit. The porcelain base, *D*, is screwed to the cork, *C*, with two screws which should be long enough to reach into the wooden piece, *B*. The flexible wire is then covered with the rubber tubing. An easy way to do this is to take a nail which will easily pass through the tubing, tie to it a strong thread, and from an upper window lower the nail into the tubing until it comes out at the other end. With the thread, a string is then pulled through, and with the string the wire in the same way. Firmly attach the string to the wire without any large knots, and also see that the ends of the wire are not likely to catch on the tubing. The wire on the lamp-end should extend about three inches to allow for connection in the bottle.

"Through the cork bore two holes from the center of the top side to the edges of the porcelain base. The wire and tubing are then put through the hole in the wooden piece, *B*, the end of the tubing being attached with bicycle or other cement to the underside of this piece. The two strands of the wire are then put through the holes in the cork and connected with the terminals of the lamp. The upper side of the cork is then covered with cement and pressed firmly against the piece, *B*. When dry, the water will not reach the wire when the cork has been inserted in the bottle. The other ends of the wire are, when ready to use, connected to the battery, and the lamp will then light. The battery is kept in the boat. The wire not in the water does not require to be covered with tubing. In use, the bottle is weighted so that it will sink to the required depth. The battery is then connected to light the lamp. The light will attract many kinds of fish. The fisher and a properly-baited line will do the rest."

THE ELECTRICITY WORKS OF SWITZERLAND AND WATER POWER.

OUR thoughts turn to Switzerland when we think of water power and hydro-electric installations. The statistics of the electricity works of Switzerland and the map of the network for the distribution of electric light and power which Professor W. Wyssling, of the Zürich Polytechnic, has recently published, however, do not appear to show the high figures and the general utilization of electric power with which Switzerland is often credited. But it must be borne in mind, however, that, as in the annual statistics compiled by the Association of Electrical Engineers of Switzerland and of Germany respectively, private installations, no matter how large, have not been included in these lists. The total electric energy which is utilized as power or light is thus considerably higher than it would appear from Dr. Wyssling's figures.

Dr. Wyssling's statistics are brought up to the end of the year 1901. When we glance at his map of Switzerland, we notice that there are four great power-distribution centers, whose mains frequently approach one another within a few miles, and, further, a number of more isolated centers. The great centers are Lausanne, with branches extending far up into the Rhône Valley on the one side and to the Lake of Neufchâtel on the other; the Jura Mountains, with Neufchâtel, La Chaux de Fond, Locle, and branches to Biel and via Solothurn to Langenthal and the Aar Valley; Berne, Thun, and Burgdorf; Zürich, Zug, Baden, Waldshut. More isolated are Basel, Lucerne, Glarus, St. Gallen and Geneva. Dr. Wyssling distinguishes between electricity works proper, which supply to customers; electric railways and tramways; and electric transmission of power by concerns which, while not serving the public, yet send their mains to some distance over grounds not their own. The electricity works proper are subdivided into primary power stations and secondary or distribution stations; the latter are generally provided with transformers, while customers are also joined directly to the primary generators. He counts altogether about 300 electricity works—namely, 235 primary and 61 secondary stations; 41 of the former are more of a private nature, while 194 serve the public directly or are operating railways. The primary power is water in 215 cases, gas or petroleum in 14, and steam in six cases. These latter figures does not comprise reserve power for the turbines; those reserves are formed by steam engines in 14, and by internal combustion motors in six cases. The available power of the hydro-electric stations fluctuates with the season. Counting only the minimum power always at disposal, Dr. Wyssling calculates that the total (minimum) capacity of the Swiss public electricity works is 110,000 kilowatts, or 160,000 horse power. When the big Zürich power scheme which has been talked about for some time has been executed, another 100,000 horse power will be added. The primary stations generate 103,200 kilowatts, 97,600 kilowatts being derived from water power, 3,100 from steam, and 2,500 kilowatts from gas, petroleum, or benzine; the private power transmissions represent 7,700 kilowatts (7,300 in steam, 200 in gas), the secondary stations 20,100 kilowatts. Thus 15 per cent of the total energy produced is consumed second hand, so to say, chiefly by electric railways, small motors, and lamps, while the large electrochemical works generally take their current direct from the primary stations.

Electric railways claim 13 per cent, lighting systems nearly 40, power 25, and electro-chemistry 23 per cent of the total power. A large portion of the power put down to the electro-chemical works is not utilized at present, owing to the depression in the calcium carbide trade. Of the 56 electric railways, seven are merely rope elevators. Thirty-seven railways obtain their power from other works; 19 have their own power plant; and eight of these latter sell light. As regards current system, we find 42 continuous-current and seven two-phase current plants for railways and tramways; triphase currents are also used on two of the rope lines. The towns of Zürich, Geneva, and Basel alone contain one-third of all the electric railways of the Confederacy.

Summing up, we see that, after all, comparatively little use only is still made of water power in Switzerland, and a rapid change in this direction is perhaps hardly likely. It is not so easy as it might appear to supply electric power to small works, when we have to rely on water as the primary power, however cheap that power may appear. The fluctuations in the water make the plants too complicated and expensive. The small manufacturer wishes to pay for current consumed, but not to submit to a minimum charge to be made in any case. Most hydro-electric stations have to insist upon a minimum payment, however; though in districts where the demand for light is constant and brisk, and relatively high rates are paid, special low terms can be offered for power. To overcome these

difficulties, Dr. Wyssling advises the construction of water accumulators on large and even grand scales, which would dispense with the elaborate provisions to be made for the times of low water, and raise the minimum capacity of the plant to a considerable extent; and, further, to tap the most promising sources of power, if necessary, at great distances. There are in Switzerland and elsewhere not a few instructive hydro-electric power stations which testify rather to the ingenuity and skill of the engineer than to the circumspective forethought of the commercial manager. The further developments of big power schemes, Dr. Wyssling points out, would be impeded by the bars which the cantonal frontiers and the existence of different authorities impose. Substitute municipality for canton, and the remark applies equally to this country. It is interesting to add that Dr. Wyssling expects more of a development of electric traction than of a growth of electro-chemical works. The electro-chemical industry has not advanced rapidly, nor is there at present any probability that it will do so in the near future. But the electric railway ought to have a future, and the electric motor is still waiting for admittance into many establishments and shops.—Engineering.

THE DUTUIT COLLECTION, PARIS.

A CHOICE collection of extremely valuable curios has recently come into the possession of the French capital, to which it was bequeathed by M. Auguste Dutuit, a Frenchman, resident in Rome for some time past, who died there on July 11 of last year. The will, moreover, made over to Paris a liberal endowment, sufficient to cover the costs of installation and keeping in order and to provide for the enlargement of the collection. Two conditions only were laid upon the city:- The perpetual care of the family grave of the legator, to be provided for by Paris; and secondly, the collection to be opened to the public within six months from his death. Should these conditions fail to be complied with, the bequest falls to the city of Rome. The second condition is evidently intended to point a lesson to the administration of Paris, a lesson which, we fear, is much needed in the majority of large corporations. To the credit of the French capital be it said that the condition has been most creditably fulfilled.

M. Auguste Dutuit died at the advanced age of ninety-one years. An elder brother, M. Eugène Dutuit, died before him in 1886. These two brothers, living at Rouen, spent a great part of their large fortune in the acquisition of curios, to the collection of which they were both devoted.

M. Eugène Dutuit had studied law, and was a member of the bar at Rouen; but his tastes were for more peaceful pursuits. From his early youth he had felt a love for finely illustrated works, for etchings and paintings. His resources enabled him to humor his inclinations, and his brother readily followed him in his hobby.

M. Auguste Dutuit had in his younger days studied art, and visited the studio of Thomas Couture. He, too, was fascinated by masterpieces of ancient art, and it was only natural that the two brothers should together follow up their joint interests.

In later years M. Auguste Dutuit, left alone in the world after the death of his brother and his sister, married in Rome, where he spent a considerable portion of his time.

FIG. 2.—THE EGYPTIAN DEITY IMHOTPU.

In matters of every-day life he practised considerable economy. A tale is told, how he brought to Rouen, in a third-class compartment, a set of three pieces of Oyron pottery, a chandelier, and two antique cups, some of the finest pieces of his collection. For these he had paid without bartering 150,000 francs ($30,000).

It may be readily imagined that this bequest raised a considerable stir in Paris. A fortnight after the reading of the will, the chief council called to an extraordinary session, authorized the prefect of the Seine to accept this munificent gift, on the conditions stated,

FIG. 3.—FIGURE OF ISIS.

and gave him full power to take such measures as would insure the acquisition and installation of the exhibits by the town within the prescribed time.

The building chosen to accommodate the valuable collection is the "Petit Palais des Champs-Elisées," which has been empty since the 1900 exhibition. The task of furnishing the building in haste, and of placing the curios in proper and artistic order was intrusted to M. Georges Cain, steward of the historical collections of Paris, who has shown great ability in his past administration of similar affairs. Thanks to his efforts, the collection was duly thrown open to the public within the specified time.

We publish cuts of a very few of the interesting exhibits of this collection.

Thus, for instance, Fig. 1 shows a specimen of Egyptian art, a spoon of carved wood, used for toilet purposes. The handle is formed of a graceful female figure. The second cut represents a bronze statuette of the deity Imhotpu, the Æsculapius of the Egyptians, holding on his knees a roll of papyrus, upon which his name is carved. In another cut (Fig. 3) we see a larger statue, in bronze, covered with verdigris of ages, representing, according to M. Froehner, an Egyptian queen as Isis, with her right arm extended and holding a snake, whose head is unfortunately broken off. The majestic bearing, the uræus or symbolic serpent fixed in front of the tiara, the knot in the belt—all these betoken the goddess Isis. The face, however, has all the characteristics of a portrait. This custom of representing monarchs as deities was common in all antiquity. In Rome also many instances of it are known. Thus the bronze statuette, Fig. 4, a representation of Venus at her toilet, holding in her right hand a mirror (now broken away), and lifting the forefinger of her left hand to her chin in a charming posture, is a portrait of Antonia, the niece of Augustus and mother of Germanicus and of unfortunate Claudius, the same Antonia whose beauty is praised by Plutarch.

A very curious relic is the amulet shown in Fig. 5. This consists of a typical Mercury's head, with its winged crest. Upon each shoulder the bust carries a cornucopia, and suspended from it are a number of bells, whose tinkling was believed to ward off evil spirits.

Very interesting is a death's head (Fig. 6), which has served as sliding weight on a steelyard. The suspending ring is formed of a butterfly, symbolic perhaps of the soul set free from its body. Another bronze object (Fig. 7), a winged head, has formed the handle of some caldron.

Very fine is the warrior's bust, in brass, once part of a chariot, which is shown in Fig. 8. The style of the armor and of the broad head-gear refers this exhibit back to the time of Alexander. Little is known of the exhibit depicted in Fig. 9. It represents a triton in the act of hurling a javelin, its fishtail lashed into sinuous folds. All the information which can be gathered about it is that it was sent to M. Dutuit from Smyrna by some person well acquainted with his passion for curios. Lastly (Fig. 10), we see a lamp, fashioned in the shape of an old man reclining, heavy with wine, upon the leather bottle which he has drained.

These are a very small selection from a most remarkable collection. Handsome, indeed, is this inheritance which has fallen to the lot of the city of Paris.

FIG. 1.—ORNAMENTAL WOODEN SPOON.

THE ORIGIN OF TERRESTRIAL PLANTS.*

By DOUGLAS HOUGHTON CAMPBELL.

I SHOULD like to invite your attention for a little while to some of the factors that apparently have been operative in determining the changes which plant structures have undergone in the course of the development of the vegetable kingdom. While some of these are perfectly obvious, others are by no means so evident, and, as might be expected, there is not perfect agreement among botanists as to the relative importance of some of these factors, nor indeed of their efficiency at all.

I shall not attempt here to go into any extended discussion of the remarkable results obtained by Prof. De Vries in his recent studies upon variation in plants. These are too important, however, to be dismissed without some mention. The conclusion reached by Prof. De Vries is that, in addition to the variation within the limits of species, there may be sudden variations or "mutations," which, so to speak, overstep the limits of the species, and thus inaugurate new species. While the results obtained, especially in the case of *Enothera lamarckiana*, are certainly most striking, more data are necessary before we can accept without reserve the conclusions reached. It is certain that marked changes—"sports" as the gardeners term them—often appear without any explainable cause, and it is equally difficult to understand, what for want of a better term, we can only term "tendencies" to develop in special directions. Thus the specialization of the sexual reproductive cells, which has evidently taken place quite independently in several unrelated lines; the development of heterospory, and probably of the seed habit in different groups independently, are hard to explain without assuming an innate tendency to vary in a determined direction.

FIG. 4.—ANTONIA AS VENUS.

FIG. 5.—AMULET, BEARING HEAD OF MERCURY.

It is not, however, with these exceedingly difficult and often obscure problems that we shall concern ourselves

* Address of the chairman of Section G, Botany, and vice-president of the American Association for the Advancement of Science. Read at the Washington meeting, December 29, 1902.

here, but rather with those changes in plant structures which are referable to more or less evident response to known conditions.

Speaking in broad terms, I think we can reduce the determining factors to three categories, leaving aside the inherent tendencies to variation. These three sets of factors are: (1) those relating to the food supply, (2) the relation to water and (3) those concerned with reproduction.

It is hardly necessary to say that there is no fundamental distinction between plants and animals. At the bottom of the scale of organic life are many forms, especially those belonging to the group of Flagellata,

FIG. 6.—WEIGHT FROM ROMAN STEELYARD.

which are intermediate between the strictly animal and vegetable organisms.

We may safely assume that the primitive organisms were motile, perhaps resembling some of the existing flagellates. Of the latter some are destitute of pigment and approach the lower Protozoa; others are provided with chromatophores containing chlorophyl and resemble the lower plants. It is highly probable that the forms with chromatophores are able to assimilate carbon dioxide, as the typical plants do, and may be denominated "holophytic." The forms without chlorophyl are probably, like animals, dependent upon organic food for their existence.

If we compare the holophytic flagellates with those forms which have no chlorophyl, a significant difference may be noted, which is evidently associated with their nutrition. The holophytic forms are noticeably less motile than the others. Thus *Euglena*, one of the commonest green flagellates, becomes encysted before division takes place. The resting cell has a firm membrane about it, and closely resembles a typical plant cell. The forms without chromatophores, however, e.g., *Scytomonas*, may divide longitudinally in the active condition. This difference in motility between the forms with and without chromatophores seems to be the first hint of the differentiation of the characteristically motile animals and immobile plants.

One group of plants (Volvocaceæ) evidently allied to the Flagellata, and sometimes even included with them, like animals, show active locomotion during their vegetative existence. Aside from these, and the Peridineæ, which may be remotely related to them, locomotion is exhibited only by such reproductive cells as zoospores and spermatozoids. The frequent reversion to the motile condition found in the reproductive cells suggests the probability that these have been derived from similar ancestral forms.

The loss of motility in typical vegetable cells is associated with the formation of a firm membrane, usually of cellulose, about the cell. This precludes all movement of the cell, except in those cases where openings are present, through which extensions of the protoplasm, usually in the form of cilia, protrude.

The power of free locomotion was probably a character of the primitive vegetable cell, but with the development of the holophytic habit, this power has been lost by the vegetative cell of most plants. The loss of locomotion in plants may probably be connected with the development of the power to assimilate carbon dioxide, the main source of food. As the CO_2 in the air, or dissolved in water, is constantly being received, it is not necessary for the plant to move from one place to another in search of food, and we find plants becoming more and more stable. Where animals are so placed that their food supply is abundantly received, they may assume an immobile plant-like habit. This is especially marked in many marine animals, such as corals, hydroids, sponges, ascidians, and such mollusks as oysters. The old name "zoophyte" applied to corals and similar animals was not in all respects a misnomer. These rooted marine animals exhibit another resemblance to plants in the development of free swimming larvæ, analogous to the active zoospores produced by so many algæ. In both instances it is safe to assume that the motile stage is older than the fixed condition.

Lack of time forbids our consideration in detail of the very important, but by no means clearly understood, problems dealing with the evolution of sex in the vegetable kingdom. Thus the reason why the development of distinct sexual cells has taken place in an almost identical manner in several widely separated groups of plants is hard to explain. The sexual cells, or gametes, have beyond question been derived from non-sexual ones. Thus in several groups of algæ; e. g., Volvocaceæ, Confervoideæ, and Phæophyceæ, there still exists an almost perfect series of forms leading from the non-sexual zoospores to perfectly differentiated male and female gametes. The formation of sexual or non-sexual reproductive elements is, in many cases at least, largely dependent upon the conditions under which the plants are grown. This has been very clearly shown by the remarkable series of investigations made by Prof. Klebs upon various thallophytes. For a discussion of the meaning of sex, the reader may refer to the recent papers on the subject by Strasburger and Beveri.

In short, while we know to a considerable extent some of the factors which determine the formation of sexual cells, where these have already been developed, the reasons why sex has developed are still very obscure.

Secondary reproductive structures, such as sporangia, seeds, flowers, fruit, etc., are readily enough explicable and need not be dwelt upon here.

PHOTOSYNTHESIS.

Perhaps the most important physiological property of green plants is the photosynthesis or the ability to utilize the energy of the sun's rays for the manufacture of the primary carbon compounds necessary to build up living protoplasm. That some of the most striking modifications of the plant body are directly associated with photosynthesis is certain. The development of leaves in various groups of plants is, perhaps, the most obvious response to the needs for photosynthesis. The leaf is, *par excellence*, the photosynthetic organ. The spreading out of the green cells so as to offer the most favorable exposure to the light rays, and in the higher plants the development of stomata and the spongy mesophyl, or special assimilating tissues, are especially perfect. Leaves are by no means confined to the vascular plants, however. We need only recall the simple leaves of mosses and liverworts and the similar organs in the more highly organized seaweeds, such as *Sargassum* or *Macrocystis*. Even among the truly green algæ simple photosynthetic organs may be developed. The dense branching tufts of *Draparnaldia* or the expanded frond of *Ulva*, for example, are of this nature.

FIG. 8.

The leaves of these lower plants are very different morphologically from those of the ferns and seed plants, but show very clearly that they are physiologically of the same nature; i. e., they are *analogous* but not *homologous*.

Other special modifications associated with photosynthesis are the peculiar lacunar tissues found in the thallus of the Marchantiales and in the sporogonium of the true mosses and in *Anthoceros*. In all these instances there are formed, in connection with the green lacunar tissue, more or less perfect stomata. These upon the apophysis of the sporogonium of many mosses, and over the whole surface in *Anthoceros*, are precisely similar to those found upon the leaves and other green organs of the vascular plants.

While it is usually stated that, among the bryophytes, appendicular organs are quite absent from the sporophyte, the apophysis, or special assimilative organ at the base of the capsule in some of the more specialized mosses like *Polytrichum* and *Splachnum*, might almost be so regarded. In the latter genus it sometimes forms a broad disk several times the diameter of the rest of the capsule, and is just as truly a special organ for photosynthesis as is the leaf of a fern or flowering plant.

WATER.

Even more important than the changes of the plant body associated with photosynthesis are those which are due to the plant's relation to the water supply. All organisms require a certain amount of water in

FIG. 9.

order that the protoplasm may perform its functions. Protoplasm is not necessarily killed by the withdrawal of water, but it is rendered inactive, as may be readily seen in such structures as seeds, spores, etc.

The lowest organisms, whether plant or animal, are virtually aquatic; for, although they do not necessarily always remain in a liquid medium, they become quiescent when moisture is withheld. Very many, like most algæ, are true aquatics, and it is safe to assume that the progenitors of the higher plants lived in the water. The nearest approach to these ancestral forms which have survived are probably certain green algæ, which have retained much of their primitive simplicity. Much the greater number of living plants, however, have given up the primitive aquatic habit for life on land. In adapting themselves to this new habitat they have contrived to exist with a much diminished water supply, which has enabled them to outstrip the much simpler forms which have retained their old aquatic habit.

The change from the primitive aquatic condition to the much more varied conditions of terrestrial existence is bound up with profound changes in the organization of the plant body.

MARINE PLANTS.

Of the existing plants which have retained the primitive aquatic habit, the most important are the various types of marine algæ, including not only the larger seaweeds, but also the minute pelagic forms like the diatoms and Peridineæ. Many of the larger seaweeds are very much better developed than the simple green fresh-water algæ, and show many special modifications associated with their peculiar environment. Not being subject to the drying up which threatens all fresh-water organisms at times, it is very rarely that marine algæ develop any form of resting-spores such as are so common among fresh-water algæ. On the other hand, those which grow between tide-marks, where they are regularly exposed at low tide, develop mucilaginous or gelatinous tissues, which prevent too complete loss of water. This is especially well seen in the large kelps and similar forms. Some of these also reach an enormous size, and develop leaves which are often provided with bladder-like floats which bring them to the surface when they are exposed to the light.

Very characteristic are the minute pelagic plants, especially the diatoms and Peridineæ, which are important constituents of the plankton, or surface life of the sea. These floating plants are generally provided with some sort of buoyant apparatus, evidently an adaptation to their pelagic life. Small as these floating algæ are individually, they are immensely important to ocean life, as they constitute the main source of food for the hosts of animals inhabiting the sea.

The great sub-kingdom of fungi offers many interesting problems bearing upon the evolution of plant-forms, but there is no reason to suppose that any higher types of plants have ever arisen from the fungi, many of which are doubtless plants of comparatively recent origin. Most of their peculiarities are

FIG. 7.—HANDLE FROM A CALDRON.

FIG. 10.

associated with their nutrition, which is entirely different from that of typical plants. Not having chlorophyl, they are, like animals, dependent upon other organisms for food. Consequently all fungi are either saprophytes, living upon dead organic matter, or as parasites they attack living animals and plants.

I cannot dwell here upon the extremely difficult problems connected with the origin and affinities of the fungi, even if I felt competent to discuss them.

THE ORIGIN OF TERRESTRIAL PLANTS.

We have now to consider what causes led to the abandonment of the aquatic habit by the algæ ancestors of the vascular plants, and how this radical change in their environment has influenced the development of the structures of the higher plants.

Nearly all fresh-water plants are exposed to destruction at times, by the drying up of the bodies of water in which they live, conditions which are never met with in the life of most marine organisms. This necessitates some means of surviving the periods of drought, and has resulted in the development of various devices for carrying the plants through from one growing period to another. While a few low aquatics, like *Pleurococcus* or *Oscillatoria*, may become completely dried up without being killed, in most fresh-water algæ there are produced special cells—spores—which are more resistent than the vegetative cells and survive the death of the rest of the plant body. These resting spores may be produced non-sexually, as in *Nostoc*, or the "aplanospores" of some of the green algæ; but more commonly they are the product of the union of sexual cells, or gametes, and may be generally denominated "zygotes."

This condition of things of course precludes growth, except when an abundant water supply is provided. It is evident that any device by which the vegetative life of the plant can be prolonged is an obvious advantage.

Some such contrivances, of a simpler kind, are seen in some of the lower green plants. Thus the gelatinous mass in which the filaments of a *Nostoc* colony are imbedded, or the "palmella-stage" of some Confervoideæ, offer a certain amount of resistance to the loss of water, and serve to prolong the period of vegetation. Less commonly rootlike organs are developed which enable the alga to live on the wet sand, penetrating into it and drawing up water from below. Species of *Vaucheria* and *Botrydium* exhibit this very well.

We may imagine that some algal form, perhaps related to the existing Confervoideæ, adopted a similar amphibious habit, developing rhizoids, by means of which it could vegetate in the mud after the subsidence of the water in which it was growing, in a manner analogous to that exhibited by certain amphibious liverworts still existing. The well-known *Ricciocarpus natans*, for example, lives first as a floating aquatic, but may later settle in the mud, as the water subsides, and there vegetates much more luxuriantly than in its aquatic condition.

The change from a dense medium like water to the much rarer atmosphere necessitates the development of mechanical tissues, to give the plant the requisite support in the air. There must also be developed devices for protecting the tissues against excessive loss of water due to transpiration. Other modifications are to insure economy of water in fertilization.

In submerged aquatic plants water is absorbed directly by all the superficial cells, and of course there is no loss due to transpiration. Moreover, special conducting tissues are made less important, and are either quite wanting, as in most algæ, or much less developed than in related terrestrial forms. As soon as a plant becomes terrestrial there must be provided organs (roots or their equivalent) for drawing up from the earth water to replace what is lost by transpiration, and in all but the simplest forms special conducting tissues to facilitate its transport. In the lower types of land plants, the absorptive organs are usually simple hairs (rhizoids), but these are quite inadequate to supply a plant of large size, and consequently it is only those terrestrial plants which are provided with a true root system that have succeeded in reaching a large size. Even in the lower terrestrial forms the rhizoids do not monopolize the absorption of water, but many of them are able to absorb water directly through the leaves or through the superficial cells of the thallus. While this is especially marked in many mosses and liverworts, which are, so to speak, more or less aquatic in their behavior toward water, it is by no means confined to them, as most vascular plants develop structures, seeds, tubers, bulbs, etc., which can absorb water directly. Less commonly the leaves of vascular plants have this property. This is especially marked in various xerophilous plants such as the Californian gold-back fern (*Gymnogramme triangularis*), *Selaginella rupestris* and other species, many species of *Tillandsia*, etc.

As all botanists know, the structural differences between aquatic and terrestrial plants are very marked, but there are some transitional forms which illustrate very beautifully the change from one to the other, and the efforts of the plant to adjust itself to the changed conditions. Thus some plants which are usually strictly aquatic, such as some water-lilies, may assume a nearly terrestrial condition, the long-stalked, floating leaves being replaced by those borne upon shorter upright petioles.

The primitive aquatic plants are either unicellular or simple cellular plants with relatively little differentiation of parts, as might be expected in organisms living in a relatively uniform medium. A necessity for their active existence is an abundant water supply, as they are not provided with any adequate means for resisting desiccation, although the mucilaginous or gelatinous substances in which their cells are sometimes imbedded serve to retard for a short time the loss of water by evaporation when they are exposed to the air. A good many of the lower fresh-water organisms are capable of becoming dried up without losing their vitality, but of course their activity is stopped. More commonly they depend upon special resting cells, or spores, to carry them through periods of drought or cold.

In exceptional cases, the lower algæ may assume an amphibious habit, living upon wet mud instead of actually in the water. *Botrydium* and some species of *Vaucheria* develop a simple root system by which the loss of water by transpiration is made good so long as the soil remains moist; but these quickly die as soon as the mud dries, as their cells are not protected against loss of water by evaporation.

It is, however, among the bryophytes, or mosses, that anything approaching a satisfactory solution of the problem of a terrestrial existence is attained. (I am leaving out of account the fungi.) All of the mosses are, to a certain extent, amphibious, since all of them require first water in order that fertilization may be effected. A small number, e. g., *Riccia fluitans*, *Riella*, *Fontinalis*, etc., are genuine aquatics, and the life history of such a form as *Ricciocarpus natans* illustrates what has probably been the origin of the terrestrial habit in the primitive archegoniates. *Ricciocarpus* is usually a floating plant, but it not infrequently assumes a terrestrial habit, sometimes preliminary to developing its reproductive organs. This is brought about by the subsidence of the water until the plant is left stranded on the sand. Under such circumstances it grows very vigorously, develops numerous rhizoids which penetrate the mud and supply it with water. Excessive loss of water is checked by the development of a cuticularized epidermis covering the exposed surface of the thallus. It is highly probable that in some such way as this the algæ ancestors of the first archegoniate plants began their life on land, and slowly emancipated themselves from the necessity of being surrounded by water, and of course thus became more and more independent of the drying up of shallow bodies of water in which they grew. In this way the vegetative period would be much prolonged, and would give the plant a great advantage over its aquatic competitors, and thus the terrestrial habit was established.

Some liverworts and mosses may reach considerable size, a foot or more in length in a few cases. They also exhibit a certain amount of specialization, corresponding to the requirements of the terrestrial environment. Well developed leaves are present in nearly all true mosses, and in many liverworts, and in one order of the latter, the Marchantiales, the plant body, while retaining its thallose character, develops a complicated assimilative tissue, with stomata of a peculiar type not found elsewhere. In the upright forms mechanical tissues are developed, and in the true mosses there is present in the leafy shoots a central strand of conducting tissue, comparable to the vascular bundles found in the sporophytes of the vascular plants. Indeed the analogies existing between the leafy moss-shoot and the sporophytic shoots of the vascular plants are sufficiently obvious.

No existing bryophytes have succeeded in reaching any but the most modest dimensions. All the larger forms either are prostrate or grow in dense tufts, offering mutual support to the leafy shoots. Indeed no moss seems to have quite solved the problem of a self-supporting upright leaf-supporting axis. Neither have they successfully solved the problem of an adequate water supply, to compensate for loss of water by transpiration, and this of course is closely associated with the limit of size which the plant-body could assume. Given an unlimited water supply, and a plant, even of low organization, may attain very large dimensions, as we see in the giant kelps. Those plants, although in many respects of very low rank, nevertheless may reach hundreds of feet in length, and develop specialized tissues, curiously suggesting those of the highly organized land plants. These giant seaweeds absorb water throughout their whole superficial area, and there is no loss of water by transpiration; but for a terrestrial plant to reach a large size there must be adequate means for absorbing water from the soil, and for transporting it expeditiously through the plant to those places where water is being lost through transpiration.

In the highest terrestrial plants, the "vascular" plants, we meet first with a perfect system of water-conducting tissue. This is the woody portion of the fibro-vascular bundles, composed of the characteristic tracheary tissue, first encountered in the ferns, and common to all the higher plants.

ORIGIN OF THE SPOROPHYTE.

Among the lower terrestrial plants, the Archegoniatæ, which comprise the mosses and ferns, a very marked characteristic is the "alternation of generations." By this is meant that in its development the plant passes through two very different phases, a sexual and a non-sexual one. This is perhaps best seen in the ferns. The spore of the fern, on germination, gives rise not to the leafy fern plant, but to a much simpler plant much like a small liverwort, upon which the sexual reproductive organs, the archegonium and antheridium, are borne. This sexual plant is known as the gametophyte. Within the archegonium is borne the egg-cell or ovum, which, after being fertilized, ultimately produces the leafy fern plant, or "sporophyte," from its producing the spores, or non-sexual reproductive bodies.

Among the lower Archegoniates, the gametophyte is relatively much more important, and the sporophyte is never an independent plant, as it is in the ferns, but always remains to a greater or less extent dependent upon the gametophyte for its existence.

An alternation of generations is hinted at among some of the green algæ, but never becomes sharply defined as it is in the archegoniates. Among the red algæ, however, it becomes clearly marked, and also in many fungi. In both of the latter cases it is extremely probable that we have to do merely with analogies, as there is not the slightest evidence of any genetic connection between either of these groups and the archegoniates.

With the green algæ, however, the case is somewhat different, and it is highly probable that the earliest archegoniates arose from some forms not very different from *Coleochæte*, a green alga in which the fertilized egg gives rise to a very simple sporophytic structure.

The increase in the output of the zygote, or fertilized egg, due to its division into a number of spores, instead of forming at once a single new individual, is an evident advantage which becomes increasingly important as the gametophyte assumes the character of a terrestrial plant, and the chances of fertilization, which requires the presence of water, become correspondingly lessened.

There are two theories as to the origin of the alternation of generations among the archegoniates, the "homologous" and "antithetic." The first holds that the non-sexual sporophyte is a direct modification of the gametophyte and probably arose from it as a vegetative outgrowth. The antithetic theory holds that the sporophyte always, in normal cases, arises from the fertilized ovum, and is a further development of the zygote which has arisen in response to the requirements of a terrestrial existence. There is not time here to consider at length the relative merits of these two theories. In a special paper before the section, I hope to bring this matter up for discussion. For present purposes I shall assume that the latter (antithetic) view is the correct one.

As the ancestors of the archegoniates left their original aquatic habitat, the question of the water supply became of the first importance. All of these lower land plants have retained many of their original characteristics, among them the development of motile male cells (spermatozoids), which require free water in order that they may reach the egg-cell and fertilize it. That is, the plants are, to a certain extent, amphibious, and must return to the water in order that fertilization may be effected. It is very clear, then, that anything which tends to increase the number of spores resulting from the developed zygote will be advantageous, rendering a single fertilization more and more effective.

The alternation of sexual and non-sexual plants among the green algæ is not sharply marked, and has been shown to be largely a matter of nutrition. Nevertheless, as already mentioned, there is a hint of an alternation of generations in certain forms like the higher Confervoideæ. In these the germinating zygote produces a larger or smaller number of zoospores, which give rise to as many new individuals. From some such form as these in all probability the primitive archegoniates arose. As these became distinctly land plants, the motile zoospores resulting from the zygote of the algæ gave place to the non-motile spores characteristic of the terrestrial archegoniates; but of any transitional forms we are quite ignorant, and the gap between algæ and archegoniates is a very deep one.

The gradual specialization exhibited by the existing liverworts and mosses is familiar to all botanists, and will only be briefly discussed here. Enough to say that from the simplest type, a globular mass of spores, with almost no sterile tissue developed, such as occurs in the Ricciaceæ, there are still found almost all intermediate conditions, culminating in the large and complex sporangia of the true mosses, and the somewhat similar but much simpler one of *Anthoceros*.

In following such a series it is clear that spore-production, the sole function of the primitive sporophyte, becomes largely subordinated to the purely vegetative existence of the sporophyte. Thus in such a moss as *Polytrichum*, the sporogenous tissue does not appear until a late period in the development of the sporophyte, and comprises but a very small fraction of its bulk. An elaborate system of assimilative tissue, with lacunar green tissue and stomata like those of the vascular plants, is developed, and the loss of water due to transpiration is made good by a strand of conducting tissue, which represents a simple type of vascular bundle.

While the elaborate sporophyte of the mosses offers certain suggestions of the structures of the vascular plants, it is much too highly specialized in other directions to make it in the least probable that it has given rise to any higher forms. The equally dependent but much simpler sporophyte of the peculiar group of the Anthocerotales is probably very much more like the forms from which this independent sporophyte of the ferns arose than is the more highly developed sporogonium of the true mosses.

The subject of the gradual elaboration of the sporophyte cannot be dismissed without reference to the very important work of Prof. Bower, whose clear exposition of the progressive sterilization of the tissues of the originally exclusively sporogenous sporophyte is one of the most important contributions to the subject.

When we review the extraordinarily large number of resemblances between both gametophyte and sporophyte in the ferns and liverworts, the weight of evidence, to my mind, is overwhelmingly in favor of assuming a real genetic connection between the two groups. To say that "no structures among plants seem to have left so little trace of its origin as do the leafy sporophytes of Pteridophytes and Spermatophytes," is certainly to ignore all the principles of comparative morphology. When we reflect that the reproductive organs and mode of fertilization are the same in all archegoniates; that the early divisions and growth of the embryo are identical; that in the more specialized bryophyte the sporophyte develops assimilative and conductive tissues strictly comparable to those of the Pteridophytes; and finally, that the spore formation is identical to the minutest details; surely such a statement is very far indeed from stating the truth.

The fallacy of the arguments based upon apogamy has been ably refuted by Prof. Bower. He has called attention to the fact that nearly all cases of apogamy are abnormal, and occur in forms where the sporophyte normally is produced from the egg. It is also noteworthy that the greater number of cases of apogamy occur in extremely variable species, such as the crested varieties of different ferns (e. g., *Scolopendrium vulgare* var. *ramulosissimum*). Prof. Bower has also called attention to the fact that these are all forms belonging to the highly specialized and relatively modern group of Leptosporangiatæ. If apogamy is a reversion to a primitive condition, it is strange that it should occur in the least primitive ferns rather than in the older types.

I think we may fairly class the phenomena of apospory and apogamy with the numerous cases of adventitious growths so common among both pteriodophytes and seed plants. In these the whole sporophyte may originate as a bud from any part of the plant. Such adventitious shoots may arise from leaves, as in many ferns, *Begonia*, *Bryophyllum*, etc.;

from roots, in *Ophioglossum*, and many seed plants, e. g., *Populus*, *Robinia*, *Anemone*, etc., or even from sporangia as in the budding of the nucellus of the ovule recorded in several cases of polyembryony. Now, no morphologist would argue from these that they are in any sense reversions, and I can not see why the case of apogamous, or aposporous budding is essentially different.

No bryophytes have quite emancipated themselves from the aquatic habit of their algal progenitors. While they may often dry up for an indefinite period without being killed, there is, nevertheless, much of the same dependence upon an ample water supply that we find in the algæ. Although much more resistent to loss of water through transpiration than are the few terrestrial algæ, nevertheless the bryophytes, as a rule, are much less suited to a genuine terrestrial habit than are the vascular plants. Much the same means are employed by many bryophytes in the absorption of water as by the algæ. Water may be absorbed by all the superficial cells, the roots playing a minor rôle as absorbents, except in those forms in which the plant is a prostrate thallus, where roots are often developed in great numbers. These delicate rhizoids, however, would be quite adequate to supply the needs of a leafy stem of any but the most modest proportions. In a few bryophytes, e. g., *Chimacium*, there are rhizome-like modifications of the shoot, which may to a limited degree be compared to roots, but any proper roots, like those of the vascular plants, are quite absent. It would seem as if nature's attempts to adapt the originally strictly aquatic gametophyte to a radically different environment had been only partially successful, owing to the failure to develop an adequate root system to restore the water lost through transpiration. It may be that the range of variation any structural type may undergo is limited.

If we accept this hypothesis, it may help to explain the significance of the alternation of generations as developed among the archegoniates, and we can understand why the sporophyte has gradually replaced the gametophyte as the predominant phase of the plant's existence. Attention has already been directed to the perfectly well-known fact that sudden marked variations may appear in plants without any apparent cause. The work of De Vries emphasizes this, and refers all radical advances in structures to such mutations, which are clearly distinguished from the variations which occur within the limits of a species, but which can not apparently overstep certain limits.

In accordance with this view it is quite conceivable that the first appearance of the leaf upon the sporophyte may have been comparatively sudden—that is, there may not necessarily have been a long series of preliminary structures leading up to a true leaf.

It has been urged that the antithetic theory of the nature of the sporophyte involves the sudden appearance of a new structure. The fallacy of this claim has been pointed out by Prof. Bower, and a little thought will show that no claim is made of the sudden appearance of a new structure. While no strictly intermediate forms are known, there is certainly no difficulty in seeing the essential homology between the rudimentary sporophyte of such an alga as *Coleochæte* and that of *Riccia*. The antithetic theory merely claims that the structure developed from the zygote, which at first is devoted exclusively to spore formation, gradually develops vegetative tissue as well, and finally attains the status of an independent plant.

The highly organized sporophyte of the higher archegoniates is connected with the lower types by an almost continuous series of existing forms, and through these with the still simpler structures found in the green algæ. The increased output of spores with a corresponding number of new plants resulting from a single fertilization, is an obvious advantage, and undoubtedly is the explanation of the origin of the sporophyte.

If we compare the sporophyte of even the simplest liverwort with that of the algæ, there is noted an essential difference. The spores, instead of being motile zoospores, are non-motile, thick-walled structures, adapted to resist drying up—in short, the sporophyte is a structure essentially fitted for an aerial existence. Except in the very lowest types, there is developed a special massive absorbent organ, the foot, which is not unlike the root developed in the higher types, and is very different from the delicate rhizoids of the gametophyte. The latter always shows, to a greater or less degree, its aquatic origin.

From the time that the sporophyte has attained the dignity of an independent existence, its development proceeded on lines very different from those followed by the essentially aquatic gametophyte. As we have seen, the efforts of the latter to assume a terrestrial habit have met with only partial success, and it would appear that nature concluded to try again, taking as a starting point the essentially terrestrial sporophyte, which, as a functionally new development, seems to have proved more plastic than the gametophyte.

From the first, and this I believe to be highly significant, its water supply was obtained indirectly through the medium of a special organ, the foot. It is not important for a consideration of the question whether the foot in all forms is or is not homologous—enough that we find for the first time an organ sufficiently massive to supply all the water needed by the tissues of the developing sporophyte. The foot is a very different organ from the delicate rhizoids of the gametophyte, and much more like the true roots of the vascular plants, which, it is highly probable, arose as further modifications of the foot of the sporogonium of some bryophyte.

With the massive root penetrating the earth and thus establishing communications with the water supply, the sporophyte becomes entirely independent. The possession of an apical meristem in the root allows of unlimited growth, and gradually the massive root system of the higher plants has been evolved, keeping pace with the increase in size of the sporophyte, which, except with rare exceptions, obtains its whole water supply through the roots. Correlated with this increase in size of the sporophyte has been developed the characteristic conducting tissues which constitute the vascular bundles. While rudimentary vascular bundles are found in the sporophyte of many mosses and in *Anthoceros*, the characteristic tracheary tissue, *par excellence* the water-conducting tissue of the vascular plants, occurs only among the latter forms.

With the establishment of the sporophyte as an independent plant, the gametophyte serves mainly to develop the sexual reproductive organs from which the sporophyte arises. While the gametophyte among the lower pteridophytes is a relatively large and independent green plant, sometimes living for several years, it becomes much reduced in size among the more specialized heterosporous types, and may live but a few hours, as in species of *Marsilia*. In such forms little or no chlorophyl is developed by the gametophyte, which depends for its growth upon the materials stored up in the spore, or even lives parasitically upon the sporophyte, as in *Selaginella*, thus reversing the relation of sporophyte and gametophyte found in the lower archegoniates.

All of these modifications are in the direction of economy of water, in accord with the needs of a more and more pronounced terrestrial habit.

Just as heterospory arose independently in several groups of pteridophytes, so also the seed habit—the final triumph of the terrestrial sporophyte over the primitive aquatic conditions—developed more than once. The female gametophyte, included within the embryo-sac, develops without the presence of free water, and the germinating pollen-spore also absorbs the water it needs from the tissues of the pistil, through which the tube grows very much as a parasitic fungus would do. Except in a very few cases, the male cells of the seed plants have lost the cilia, the last trace of their aquatic origin, and are conveyed passively to the egg-cell by the growth of the pollen-tube.

Once firmly established as terrestrial organisms, and the problem of water supply solved, the further development of the seed plants is too familiar to need any special comment here. The great importance of water in affecting the structure of land plants is seen in the innumerable water-saving devices developed in the so-called "xerophilous" plants, seen in its most extreme phase in such desert plants as cacti, or in the numerous epiphytes, like many orchids and bromeliads.

In short, it is safe, I think, to assert that of all the extrinsic factors which have affected the structure of the plant body, the relation to the water supply holds the first place. The most momentous event in the development of the vegetable kingdom was the change from the primitive aquatic habit to the life on land which characterizes the predominant plants of the present.

THE WORK OF THE GERMAN ORIENT SOCIETY.

THE following account of the recent work of the German Orient Society, of Berlin, on the pyramid of Abusit, contains some interesting information. The report of the Society's work for the last year is of no little interest.

In their excavations, the German professors found a great king carved out of stone. So great was he that the great gods, Sechmet the Lion-headed, Anubis the Jackal-headed and the Nile gods are shown bowing before him. Upper and Lower Egypt were his. When he died men began to build a vast temple of the dead for him.

"Four thousand and five hundred years ago they buried Ne-woser-re, the King. And the centuries passed and his temple unfinished, disappeared below the drifting sands. He and his family, his royal favorite and his high priests, became hidden deep below the dwellings of succeeding kings and priests and their tombs were piled over all. Then they, too, sank away and were forgotten. Others built and died—Egyptian, Greek and Christian in their turns. The great clock of history still wanted a thousand years to the time of the coming of Christ, and Ne-woser-re the King was so utterly lost and forgotten that the poorest of the poor were buried on top of the mound that hid his imperial tomb—that tomb which had been set by its mighty builders to defy eternity itself.

"And the German professors dug out a song, too. It was deemed to be immortal when it was written. So grand did it seem 2,400 years ago that a singer in Egypt had it put into his tomb with him. It is a great roll of papyrus—a poem by Timotheos glorifying the victorious sea fight of Marathon, and almost certainly the very oldest Greek book ever found. The poem that made such a vast stir once has lain under the Egyptian sands for more than 2,000 years, and songs of Marathon have piled on songs and been forgotten as the dead piled on the dead over the tomb of the Egyptian singer.

"Professors Borchardt, Voelz and Decker conducted the work of excavation. Their first discovery was the fore court of the Temple of the Dead. It had been left unfinished, and most of the beautiful columns that had been completed had fallen. But two magnificent pillars were left. In that courtyard was found the partly broken figure of a lion, grandly proportioned and far beyond life size. Its sculpture is so fine that the scientists agree that it was the work of a sculptor of extraordinary talent. The head was perfectly preserved. The great temple relief of all was found between the hall of columns and the holy of holiest. It shows the king himself, with apron and lion's tail as insignia of his high rank. He wears a headdress of feathers and horns. The jackal-headed god Anubis steps toward him, bringing him the sign of life. In a small relief Ne-woser-re is pictured with raised club slaying a group of men whom he holds by their hair.

"In digging out the Chamber of Statues the explorers unexpectedly came upon a splendid painting. It was intended to show a door set into the solid wall. The colors, laid on by hands and brushes of which there has been no vestige left on earth for 4,000 years, were bright and glowing, shining out of their long-kept darkness into the light of to-day as if they were still wet. But scarcely had the sun streamed in before they began to pale. Fortunately, the expedition numbered a skillful painter among its members, and he succeeded in making a true copy in full size of the ancient work of art. Then the diggers reached the tomb of the high priest, Jen-em-Jechwet. After breaking out the first stone the Europeans peered in and for the first time in forty-five centuries human eyes looked upon the coffins of the priests of Ne-woser-re.

"A handsome coffin in another chamber contained the mummy of a man who must have been exceptionally rich, for around his neck was a string of real pearls, while others, even high officials, had to be content with painted ones. The gifts that had been placed by his side made a little history of that age in themselves. In a niche at the head of the coffin were stone vessels, bound with leather, that had contained salves and precious ointments. There was a bed resting on carved lion's claws. Under it stood a waxen vessel and two bags filled with what apparently were face paints. A whole set of carpenter's tools was found in the rear of this chamber. There were saws, drills, augers, axes, awls, and polishing stones. When the coffin was dragged out a new surprise waited in a cavity behind. There were beautiful models of ships of the dead. One was shown with bellying sail; another, with lowered mast, was being moved by rowers.

"There was the dead man's kitchen in a miniature model. A butcher is in it, cutting the throat of a steer. Another is catching the blood. The aprons of both are bright red with it. Alongside of them squats another, a cook, broiling a goose on a spit. The model has many figures of female servants. Some are grinding corn, others are baking bread. Another model was that of the granary. In the courtyard is shown the delivery of the grain. Servants are seen carrying it upstairs, where it is poured into the bins in the upper story. A woman was found next. She was a Sat-Nofer, the favorite of the King. In that gorgeous life of 4,500 years ago, no doubt she had been beautiful and clothed with rich apparel and surrounded with loveliness and luxury. But in death she was not to lie as lay the true queen or her master.

"Placed in a rude coffin of thin wood, she was put away in a bare chamber far from the habitations of the royal dead. Hardly any gifts were laid with her. Instead, as if in irony—a grim joke that was to wait for inconceivable time to make its point—they laid by the coffin of the poor, forgotten courtesan a bronze mirror without a handle, and a little stone used for grinding rouge. As the digging progressed from this point this history of decline became uncovered. When the explorers reached the remnants of the period 2,000 B. C., they found habitations of priests, showing that the temple had votaries. But they were poor and meager like the ruined graves of the caliphs. And when the workers reached the remains of 1,300 years B. C., they found that dust and sand had even then buried the glorious dynasty, and over them were hundreds of men's graves.

"When the party reached the Greek period the great discovery was made of the poem by Timotheos. It was found in a mighty wooden coffin. Unrolled, it proved to be about four feet long, containing five columns of Greek verse written in ancient uncial characters. It is the oldest Greek book, undoubtedly older than the time of the beginning of bookmaking as originated by the founding of the Alexandrian Library. The man in whose coffin it was found was certainly buried early in the fourth century before Christ. It is a lyrical text, not that of a dilettante like Isyllos, but of a true poet, one whom the men of his day hailed the greatest poet of the world. It is intended to be sung. It takes the place of the epic song of previous times. It sings the song of the sea fight in Marathon."

ON THE SUSPENSION OF LIFE AT LOW TEMPERATURES.*

OUR first experiments were made with organisms possessing varying degrees of resistance, the extremes in this respect being represented by the sensitive spirillum of *cholera asiatica* and the resistent spores of *bacillus anthracis*. Ten organisms altogether were used and cooled down to —190 deg. C., in the first instance for twenty hours, and eventually for seven days. These exposures did not produce any appreciable impairment in the vitality of the organisms, either as regards their growth or their characteristic physiological properties, such as pigment and gas production, pathogenicity, etc. Among the organisms tested were photogenic bacteria, and these likewise preserved their normal luminous properties; and we were able, through the kindness of Professor Dewar, to apply a still severer test—namely, an exposure to the temperature of liquid hydrogen (about —252 deg. C.) a temperature which is as far removed from that of liquid air as is that of liquid air from the average summer temperature. Ten hours' exposure to this temperature had no appreciable effect on the vitality of the micro-organisms tested. At such temperatures it must be assumed that the chemical metabolism of the cell ceases, in the absence of heat and moisture. At the same time it appeared to us advisable to test the influence of a prolonged exposure to low temperatures on the vitality of cells. The experiments were conducted with the aid of the liquid air plant at the Jenner Institute of Preventive Medicine. The organisms employed were the *B. typhosus*, *B. coli communis*, *Staphylococcus pyogenes aureus*, and a *saccharomyces*. The bacteria were suspended in small loops of platinum wire or on cotton-wool swabs, and directly immersed in the liquid air. The yeast, washed and pressed, was wrapped in rice-paper, and likewise directly immersed in the liquid air. Samples were taken and tested at intervals for a total period of six months. In no instance could any impairment of the vitality of the organisms be detected. The yeast gave a good growth, and exhibited its fermentative powers unaltered; the typhoid bacillus retained its pathogenic and other properties; the *Staphylococcus aureus* gave a characteristic pigment growth; and the *colon* bacillus responded to all the typical tests that were applied to it. Judging by the results, the experiments might have been prolonged for a much longer period than six months without appreciable influence on the vitality of the organisms in question.

The ordinary manifestations of life cease at zero, but at —190 deg. C. we have every reason to suppose that intra-cellular metabolism must also cease—as a

* Abstract of a paper read by Mr. Allan Macfadyen M.D., and Sydney Rowland, M.A., before Section K, British Association, Belfast.

result of the withdrawal of two of its cardinal physical conditions—heat and moisture.

It is difficult to form a conception of living matter under this new condition, which is neither life nor death, or to select a term which will accurately describe it.

It is a new and hitherto unobtained state of living matter—a veritable condition of suspended animation.

"THE SVEA" HILL-CLIMBING BICYCLE.

THE use of levers instead of cranks for actuating the driving wheel of a bicycle is certainly old, and we believe, even, that it antedates the use of the chain and multiplication gearing; and yet, while the number of machines in which the latter is employed is very great, scarcely a dozen of the others are to be found in France. Such a set-back to the lever machine is due to manifold causes that it would take too long to examine in this place, but the principal ones of which are the construction, which is slightly more complicated and requires more care, and the consequently higher price. To this may be added the necessity of having the wheel free, a feature which, not more than a year ago, was considered by the majority of bicyclists as very dangerous. This, however, has ceased to be an objection, since it has become possible to procure good brakes; and, before long, machines with cranks will not be desired. The principal objection having been done away with, the question of cost becomes secondary, since it will be easily possible to remain within reasonable limits; and the question of construction can be solved by skillful mechanics.

It is probable, then, that a few months hence we shall have a chance to examine lever machines of French manufacture; but, in the meantime, we are obliged to go for them to foreign countries, where also they are very rare. But we speak, of course, not of isolated experiments, but of industrially constructed bicycles. In this line, we are now able to make known a Swedish machine, the "Svea," which has made its mark (Fig. 2). We have recently had this placed at our disposal, and have been astonished at the manner in which, with equal gearing, we have been able, without the least fatigue, to climb hills that we had never been able to mount with a bicycle provided with cranks. Our opinion as to the value of this machine is confirmed by Lieut. De Saint-Seine, of the navy, who has owned one for more than a year and has made very difficult excursions with it upon the uneven roads of Brittany, in all kinds of weather, and sometimes with 44 pounds of baggage.

At first sight, the machine appears to be delicate and complicated, but practically we find that all the parts are very strong, and necessitate no further cost of keeping in order and repair than do those of ordinary bicycles. The method of actuating the driving wheel through the pedals requires three chains, and, for the sake of clearness, we have indicated by a diagram (Fig. 1) the principle upon which it is

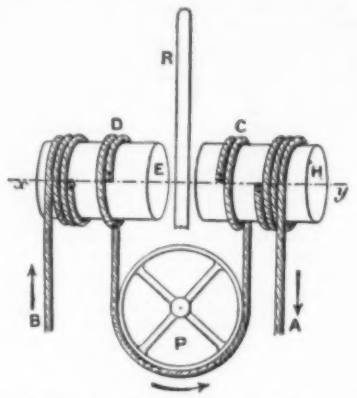


FIG. 1.—DIAGRAM SHOWING THE METHOD OF ACTUATING THE DRIVING WHEEL.

based. Let us suppose two cylinders, *E* and *H*, independent of each other and revolving freely upon an axis, *X Y*. Upon each of the ends of these cylinders we wind cords, *A* and *B*, an extremity of which is fixed upon the cylinder, while the other runs to its pedal. Upon the interior ends, and in contrary direction, we wind the extremity of a single cord, *C D*, which passes over a wheel, *P*, having a fixed position. Under such circumstances, it will be seen that if we bear upon the pedal attached to the extremity, *A*, the play of the cords will cause the ascent of the pedal attached to the extremity of *B*, and *vice versa*. The pedals are therefore operatively connected, and one must always ascend to the same degree that the other descends. As for the cylinders, they will always have an inverse motion. Consequently, if we suppose that a ratchet gear permits them to revolve the wheel, *R*, in a certain direction only, it will always be one of the two cylinders that, under the action of the pedal, will produce such motion. This latter will take place, whatever be the pedal's travel, which may, at every instant, be made as long or as short as desirable.

Such is the principle of the hub of the "Svea." Of course, the section of this member would not give a figure at all comparable to our diagram. The two parts of the hub are concentric, and the gear upon the driving wheel is very peculiar. We cannot enter into the details of construction of it in this place, since it would necessitate too long an explanation. We shall nevertheless make known the mode of winding the chains upon the hub, *M* (Fig. 3, No. 1). Considering the right hand solely, we see that the chain, *H*, passes over a spiral guide, *L*, arranged eccentrically upon the hub, with which it is operatively connected. The same is the case with the other side. By reason of such an arrangement, the value of the stroke varies at every instant, and the greatest length must correspond to the most unfavorable position of the leg—that for which the stress to be produced is most laborious. The third chain, *E*, is simply guided (Fig. 3, No. 2) by a wheel, *F*, situated under the frame and performing the function of a guide pulley. It constantly raises the pedal opposite that upon which pressure is exerted. As may be seen from an examination of the figures, it is never indispensable to exert a full pressure upon the pedal. The action may cease at any instant on one side and be resumed upon the other. This explains the advantage of machines of this kind for the climbing of hills, since the fatal dead point of crank machines is here eliminated. In the latter, in fact, we are always obliged to finish half a revolution for each foot. At the moment at which one of the pedals reaches the top of its travel and the other the bottom, there is no action possible and the machine advances only by virtue of the speed acquired. It is therefore necessary that it shall be possible to exert a push that shall be sufficiently powerful to exceed the dead point, else a stoppage will invariably occur. With levers, on the contrary, provided the machine be run at a gait that permits of maintaining one's equilibrium, there is always a forward motion. Having examined the method of attachment of one of the extremities of the motor chains of the hub, it remains for us to show where the other extremity ends. Let us examine the right-hand side of the machine (Fig. 3, No. 2). It will be seen that the point of attachment ends at a lever, *A*, forming a right angle with the one, *B*, which carries the pedal. It has the same length (10 inches), but the point of attachment is movable. The chain terminates, in fact, in a stirrup that carries a roller, *R*, which enters the notches (Fig. 3, No. 3) formed in the length of the lever. The part of the latter utilized may therefore be raised at will, and, consequently, the push to be exerted in order to propel the machine forward will be so much the less in proportion as the point of attachment is lower. The length of chain unwound during a complete revolution of the pedal naturally varies with the position of the point of attachment, upon the lever, and it is this that constitutes the change of speed. To the lower notch corresponds a travel of 12.46 feet, and we afterward have the choice between four other speeds up to a maximum of 30 feet, which is the one most employed and can be preserved even on slight declivities. Such displacement of the point of attachment of the chain upon the lever may be effected without one's leaving the saddle, by pushing a button placed upon the handle bar. This is one of the most ingenious parts of the machine. From this viewpoint, each side is independent of the other. Upon each side of the handle bar there is a button that effects the shifting of the corresponding chain. As a general thing the same multiplication is used for each part; but, in case one of the rider's legs was weaker than the other, this might be compensated for by furnishing it with a lower gear. In order to understand the manner in which the displacing of the point of attachment is done, it is necessary to take into consideration the different positions that can be taken by the stirrup that terminates the chain and carries the roller, *R* (Fig. 3, No. 3), according to the inclination of the lever. Our engraving represents about the intermediate position, but the inclination is at certain moments very marked, either toward the front, when the pedal is at the bottom of its travel, or toward the rear, when it is at the top of its travel. In these extreme positions, the traction exerted by the chain upon the roller, *R*, would tend to cause it to leave the notch in which it happens to be placed; but, to offset this, two small hooks, *C*, are arranged upon the stirrup in such a way as to enter the three apertures formed in the anterior face of the lever. In the position represented here, since the traction is exerted normally, the hooks do not act; but if we imagine the stirrup and lever as forming an acute angle, instead of a right angle, we shall see that one of the hooks—either the upper or lower one, according to the direction of the inclination—will enter one of the apertures and keep the roller in place. In order that the roller may pass from one notch to another, it will therefore suffice to prevent the action of the hook, *C*, and this may be done by pushing the button placed upon the handle bar. We compress a rubber bulb, *P* (Fig. 3, No. 4), which, through a small tube, *T*, transmits the pressure to a bulb housed in the stirrup and so arranged as to disengage the hook, which having been done, the roller will immediately move to the following notch. It follows from this that it is necessary to select a certain position of the pedal according as it is desired to increase or diminish the speed. The speed can always be changed by dismounting from the machine and displacing the roller, *R*. Despite its apparent fragility, this system operates perfectly, and if, in consequence of an accident it becomes necessary to replace the rubber tube, or even the bulbs, that can be done instantly.

The machine is provided with a brake, *F* (Fig. 3, No. 2), situated near the guide pulley of the chain, *E*. This acts upon the tire of the hind wheel, when the two pedals being at the same level, the rider rises

FIG. 2.—GENERAL VIEW OF "LA SVEA," A LEVER BICYCLE.

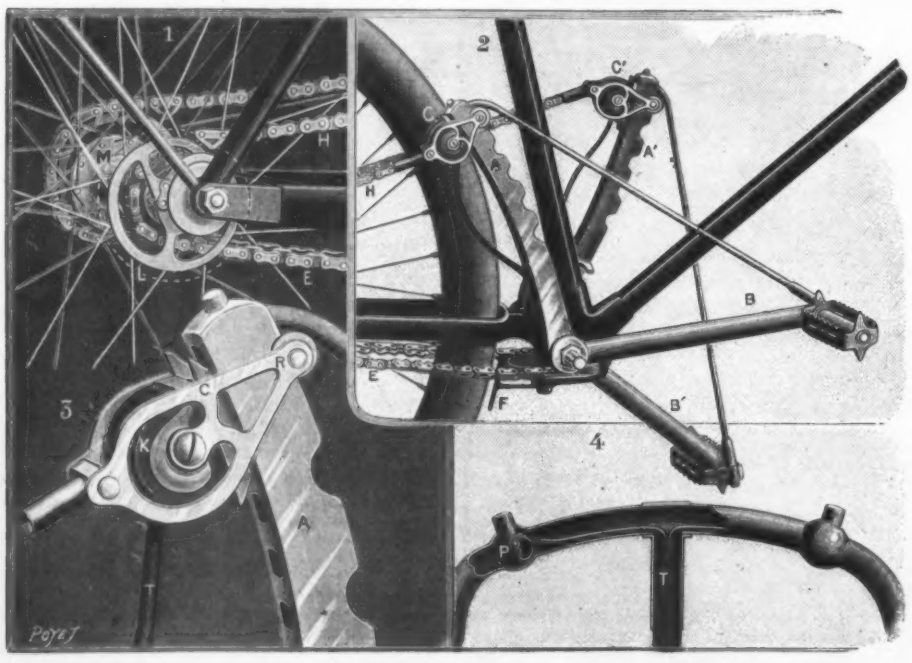


FIG. 3.—DETAILS OF THE MECHANISM OF "LA SVEA."

1. Method of winding the chains on each side of the hub. 2. Levers of the pedals and chains. 3. Method of attaching the chain permitting a change of speed. 4. Details of the compressed-air transmission.

slightly from the saddle so as to allow his weight to exert the pressure necessary to apply the brake.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

PUMPING PLANT FOR SYDNEY.

AN electrical pumping plant has just been shipped from Manchester by Messrs. Mather & Platt, Limited, which presents some points of interest. Especially is this the case in respect to the promptitude with which the plant has been made and dispatched to its destination. The order for the plant was received on August 14, by cable from Messrs. Gibson, Battle & Co., the Sydney agents of Messrs. Mather & Platt, Limited, and the whole of it was put on board s.s. "Medic," which sailed from Liverpool on October 23, leaving nine weeks for the manufacture. We always like to call attention to cases of this kind. Another point which we think is well worthy of mention is that the whole plant from steam engine to pump was constructed by one firm. Indeed, it would seem to be the tendency of modern electrical works to make as much plant as possible outside pure electrical machinery.

We took an especial interest in this plant, and were enabled to witness, by the courtesy of Messrs. Mather & Platt, the final stages of its construction and testing. It consisted of a combined engine and dynamo with surface condenser, and a combined motor and high-lift centrifugal pump, together with two switchboards fitted with the necessary instruments, etc., one for each end of the line, and a special motor starting switch. It is destined for pumping water for the Sydney water supply, the pump being installed at a distance of one and a half miles from the dynamo.

The engine of the combined set is one of Mather & Platt's double-acting open vertical marine type, compound and condensing, capable of indicating 500 horse power when running at 150 revolutions per minute, with 160 pounds of steam.

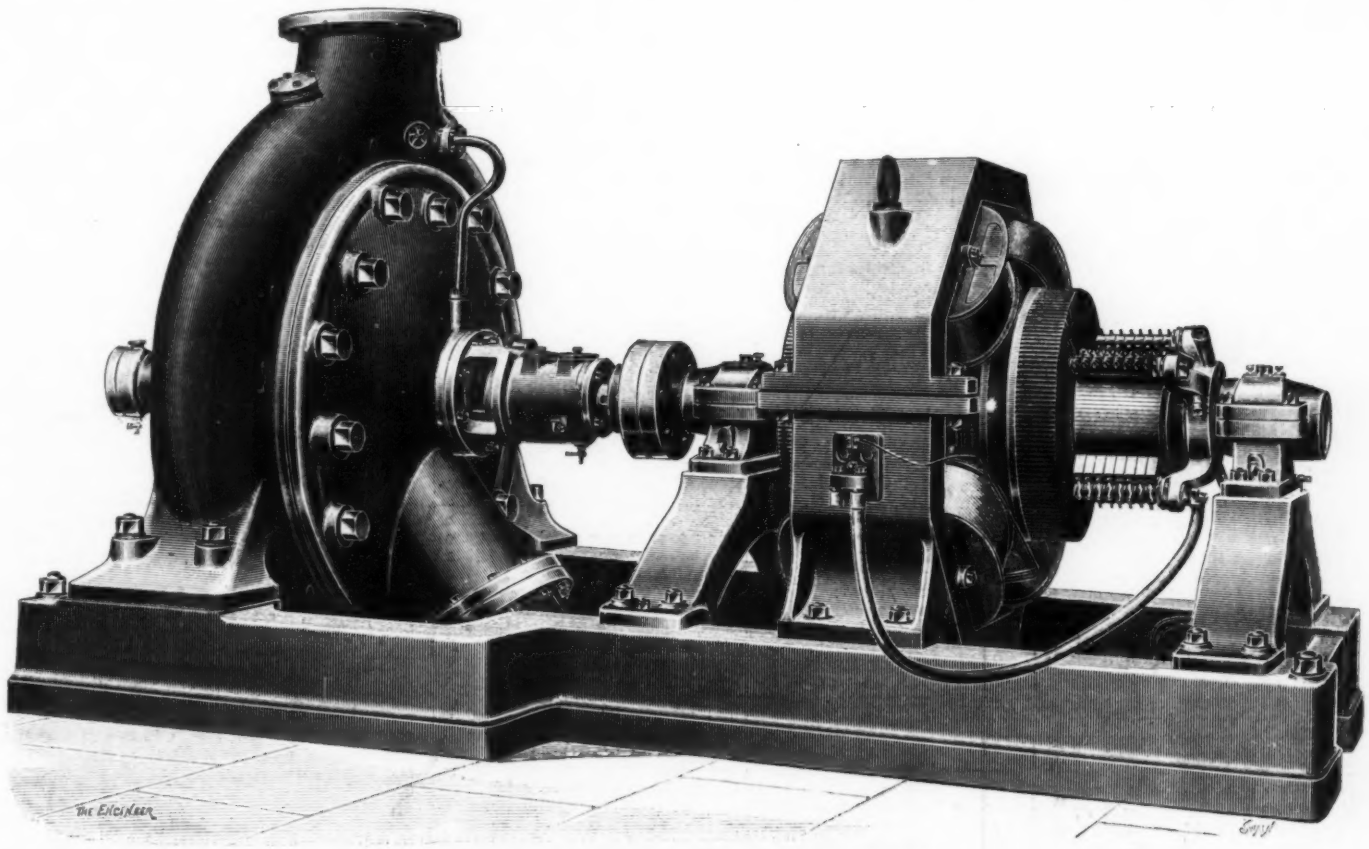
The dynamo is carried on an extension bed-plate, the armature spider being bolted directly to the outer face of the boss of the engine flywheel. The dynamo has eight poles, and is compound wound to give an output of 550 amperes at 550 volts. The yoke ring of cast steel is circular and in two parts. The poles are of cast steel, the pole shoes being specially shaped with the object of providing uniformity of magnetic flux, and of giving fixity of lead under varying load. The shunt and series windings are wound on aluminium spools, into which the pole pieces are slipped, before the latter are bolted up to the yoke ring. The armature is drum-wound, the insulated stranded conductors being placed in slots cut in the core plates.

Coming now to the pumping plant, the electric motor is similar in construction to the dynamo already described, save that it has only four poles, which are cast in one with the steel yoke ring, instead of being bolted to it, and is shunt wound. It is intended to work with 500 volts at its terminals, and to give out 345 brake horse power when running at 720 revolutions per minute.

Directly coupled to the motor is the high-lift centrifugal pump, as will be seen from the accompanying engraving. It is designed to deliver 2,800 gallons of water per minute to a height of 265 feet. Now, 265 feet corresponds to a pressure of 112 pounds per square inch, and at the test at the works before shipment the gage showed 119 pounds.

The motor is started by a combined water resistance and switch, which possesses several features of interest. This consists of a cast-iron square tank, standing on four porcelain insulators; the tank is filled with water, to which a small quantity of soda has been added to increase its conductivity. Fixed across one end of the tank, but insulated from it, is a wrought-iron shaft; this carries two cast-iron blades in the center, and at one end outside the tank an insulated hand wheel. Attached to the rear side of the shaft is a piston, working in an oil dashpot, to prevent the switch being operated otherwise than slowly. An insulated terminal on the tank is in connection with, say, the positive supply main, and through a flexible spiral copper band with the shaft and cast-iron blades; a second terminal, not insulated, on the tank is in connection through the armature of the motor with the negative supply main. The shunt magnets of the motor are connected on the one side to the negative supply main, and on the other to one end of the coil of an electro-magnet fixed to the front of the tank, which serves as a safety lock and automatic release for the switch. The other end of the electro-magnet coil is connected to a spring contact with carbon tips dipping below the surface of the water in the tank, and also to spring contacts into which enters a knife switch affixed to the main shaft.

On moving the hand wheel round, the blades first make contact with the water, and immediately afterward one of them is in metallic contact with the side spring mounted carbons below the surface; this completes the circuit through the shunt winding of the motor and fully excites the field; at the same time the magnetic lock and release is energized. The next gradual movement of the hand wheel brings the knife switch into the corresponding spring jaws, short-circuiting the under-water carbon contact, which is only in action at the first making and last breaking of the current, and thus prevents any injurious sparking. A small current is now passing through the motor armature by way of the insulated terminal, the spiral copper strip, the shaft, blades, water, tank, and insulated terminal; by further depression of the blades into the water, a larger and larger surface is immersed, and the resistance in the armature circuit gradually reduced, until, finally, two knife switches, affixed to the blades, enter two spring contacts on the iron box, and the whole water resistance is cut out. At the same moment the electro-magnetic lock acts and holds the switch "on" in opposition to a counterpoise on the hand wheel; should the supply be interrupted, this electro-magnet ceases to act, and the counterpoise carries the switch over into the "off" position.—The Engineer.



PUMPING PLANT FOR SYDNEY WATERWORKS.

BOG-FLOWS.

WRITING on the subject of the life and death of bogs, Mr. R. Lloyd Praeger says in Knowledge for November that "A bog may sometimes meet destruction in a way which is always dramatic, and may involve serious catastrophe. This happens when, owing to continual growth, the bog becomes unstable, and either slides bodily, or ruptures its walls and emits its contents. In order to understand how this takes place, we must study the structure of the bog. The thirty or forty feet of material which in a large peat-bog separates the surface from the underlying solid ground is not by any means of a consistency as firm as that of the surface layer. The intertwining stems and roots of the growing plants form a light matted felt which is comparatively firm, especially toward the margins of the bog; in the center there are often holes in the crust, filled with mud or water, and connecting with the interior. This interior is fluid compared with the crust. The decomposed matter of the surface layers sinks to the bottom, and may form there a comparatively dense deposit, but the middle layers consist of thin mud, and often contain vast quantities of water, which either descend from the surface in wet weather, or ascend from springs in the bottom of the bog. The felted crust is usually sufficiently strong to resist the pressure of the semi-fluid interior, even on large bogs which are situated on sloping ground; but exceptional circumstances may cause rupture. An unusually wet season may swell the bog beyond the point of stability; or the stoppage of underground channels may cause great gatherings of water, and ultimate collapse of the crust; or turf-cutting injudiciously carried out may weaken the margin of the bog; and a bog-flow may result." Of the fatal bog-flow of December 28, 1896, near Killarney, whereby Lord Kenmare's quarry steward, his wife, and six children, lost their lives, and much arable land was destroyed, Mr. Praeger writes, from his own knowledge: "This was a large bog, 750 feet above sea-level, lying on a watershed, and draining in three directions. The rupture took place along the face of a turf-cutting, and a vast flood poured forth, overwhelming two roads and the cottage in which the unfortunate Donelly family were asleep, and rushed down the valley with diminishing violence till it reached the Lake of Killarney, fourteen miles away, in which some of Donelly's furniture was afterward found floating. The flood continued in diminishing quantity for five days, not regularly, but intermittently, as fresh portions of the bog gave way, with loud noises, and slid into the torrent, the lighter upper crust being borne along in floes on the surface of the inky flood."

[Continued from SUPPLEMENT No. 1413, page 22648.]

THE ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA, AND GEOLOGY AND GEOGRAPHY AT THE CONVENTION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.*

By EDMUND OTIS HOVEY.

BEFORE the Geological Society Prof. Israel C. Russell described, with lantern illustrations, four groups of recent volcanic craters in Idaho and Oregon, namely: the Cinder Buttes, Idaho, and the Diamond, Jordan, and Bowden craters, Oregon. The craters in each of these groups are remarkably fresh and furnish typical examples of both cinder cones and "lava cones." Vast volumes of lava were poured out from each of the groups of craters, which at the time of its extrusion was highly liquid, but became exceedingly viscous as it slowly cooled. Illustrations were shown of cinder cones; lava cones; driblet cones or "ovens;" lava "gutters;" a large variety of volcanic bombs; dunes of lapilla; large fragments of tuff derived from cinder cones ruptured by escaping lava and floated on the lava streams; islands in lava streams; characteristic features of the surfaces of lava streams, etc.

At the Denver meeting (1901) of the Association and the Society, Prof. T. C. Chamberlin, of Chicago University, gave a concise summary of his "Planetesimal Hypothesis" for the explanation of the origin of the solar system. At the Washington meeting just held, he elaborated this hypothesis and showed its application to the explanation of the origin of ocean basins, setting forth the simple self-selecting process by which they were perpetuated and deepened, and the connection of this with the dynamics of deformation. The planetesimal hypothesis of the origin of the solar system differs fundamentally from the Laplacian and other gaseous hypotheses, and from the meteoroidal hypothesis as set forth by Lockyer and Darwin. These latter assign the extension of the parent

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

nebula to the opposed movements, collisions and rebounds of the constituent molecules or meteoroids. The former assigns it to concurrent orbital movement. In the gaseous and meteoroidal hypotheses (as usually understood) the aggregation is the simple work of gravity following a reduction of the oscillatory and colliding action. In the planetesimal hypothesis the aggregation is dependent on orbital conjunction. In the former the aggregation is massive and relatively rapid; in the latter the aggregation is individual and relatively slow. In the gaseous hypothesis the temperatures are necessarily very high, and the planets are formed by detachments. In the meteoroidal conception of George Darwin, the conditions are practically the same, and in that of Lockyer they differ rather in degree and in detail than in essence. In the planetesimal conception the planets grew up separately by innumerable accretions of infinitesimal planetoids (planetesimals) and the external temperatures were not necessarily high, since the orbits of the planetesimals were normally direct and concurrent and the aggregation came about by overtakes in contradistinction to opposed collisions, and the frequency of these was limited by ,the concurrent direction of orbital movement.

"The Economic Geology of Michigan," by Alfred C. Lane, Lansing, Mich. The author defines Economic Geology as the science of raw materials. The effect of the presence of these materials upon industry, and the effect of geological conditions upon their development, were illustrated by reference to several Michigan products. Such factors were considered as the position of the State in the center of the Great Lake distributing system, the tilting of the Great Lake basin and its effects, the mutual relations of coal and iron, and the development of the iron-ore business, the peculiarities of lake copper as compared with that of the far West. Salt, limestone, and lumber, and their mutual relations, the coal basin and the causes of its retarded development, were among the topics discussed.

"The Saddleback Topography of the Boone Chert Region, Arkansas," by A. H. Purdue, University of Arkansas. The rocks exposed in northern Arkansas are those from the Silurian to the Upper Carboniferous inclusive. The position of the rocks is essentially horizontal. In the western part of the region north of the Boston Mountains, the prevailing surface rock is the Boone chert; but in central northern Arkansas, erosion has continued far below the Boone chert, exposing the Silurian rocks, except where there are Monadnocks. The spurs between these streams are frequently surmounted by one or more knobs, which produce the saddleback topography so common in the region. These knobs are always capped by fragmentary Boone chert, which in some cases is partly water-worn. The water-worn material is of steam origin. The knobs owe their existence to the formation of alluvial cones by former streams at the time when the stream-beds were on the level of the present knobs. The cones of the fragmentary chert obstructed the streams, causing them to shift laterally, and at the same time protected the subjacent rocks from erosion. The material that composes these cones was transported rapidly and but a short distance, and as a result had but little opportunity for becoming rounded. The present drainage of the region is like that at the time the Boone chert was the prevailing surface rock only as regards the master streams; and the change is due in a large measure to the shifting of the streams brought about by their own obstructions.

"Scientific Relief Maps," by George Carroll Curtis. For years past the scientific bureaus of the United States have deemed it advisable to construct relief maps. A perfect topographical relief map is an exact miniature or model of nature, and natural principles should be employed in its construction. Truthful topographic modeling is an exact art requiring accurate, rational, and systematic methods throughout the gathering of data upon the field, and the application and reproduction of the facts of nature in other dimensions. Modern scientific inventions, including contour maps and dry-plate photography, are aiding in bringing this work toward perfection and into recognition.

"Studies in the Glaciation of the Berkshire Hills, Massachusetts," by Frank B. Taylor, Fort Wayne, Ind. The Berkshire Hills lie within the area covered by the retreating Hudson Valley lobe of the Labrador ice-sheet. The retreat of the ice-front across Berkshire County was from southeast to northwest and the trend of the front was northeast and southwest, the apex of the lobe resting on the central axis of the Hudson Valley. In Berkshire County, continuous tracing is not possible, the borders there being marked by fragmentary terminal and lateral moraines, mostly very slender, and by remains of border drainage. The extremely serrate character of the ice margin at each of the several halts, coupled with the frequency of the halts, make interpretation difficult. Mr. Taylor concludes that, by the circumstances of the recession across this country, the moraine marking each halt of the ice-front may be safely regarded as an individual, separate and distinct from the moraines of earlier and later halts. The little ice-tongues of the Berkshire Hills were small projections or excrescences on the edge of the Hudson Valley lobe, deriving all their ice from that lobe, and depending upon it for their maintenance. These tongues, therefore, partook of the oscillatory movements which affected the lobe as a whole, but had no dissynchronous oscillations among themselves, and anything that affected that stream affected them. By a little interpolation the tongues may be connected together in a series of serrate lines marking the positions of the icefront at its several halts, fifteen or sixteen in number, as it retreated across Berkshire County.

"Origin of the Sandhill Topography of the Carolinas," by Collier Cobb, Chapel Hill, N. C. Many of the sandhills show the structural features of æolian cross-bedding seen on Hatteras. Unlike most dune sands, those of the Carolina coast contain many fragments of potash felspar, being essentially the same in composition as the beach sands, which may account for the presence of the potash in the coastal plain soils, while explaining the origin of some of the topographic features.

"Recent Changes in the North Carolina Coast, with Special Reference to Hatteras Island," by Collier Cobb. Hatteras Island is being added to on the sound side and taken from on the ocean side north of the cape, and a new inlet is being made between the cape and Kinnakeet. South of Cape Hatteras the island is growing on both sides, but is extending in a southeasterly direction. The rate of change has been noted by the planting of cedar posts and noting the changes of shore line with relation to posts, trees, and various natural objects through the years 1892-1902.

In a paper on "The Hanging Valleys of Georgetown, Colorado," Prof. W. O. Crosby, of the Massachusetts Institute of Technology, expressed the conclusion that the part of the main valley occupied by Georgetown is, like the Yosemite Valley, due in part to displacement and not wholly to erosion. He also advanced the idea that the elevation of this, the oldest of the Colorado ranges, has been recently and may be still in progress, with accompanying tilting of the Cretaceous peneplain.

"The Problem of the Loess in the Missouri Valley Compared with That in Europe and Asia," by G. Frederick Wright, Oberlin, O. The physical resemblances between the loess deposited in the Missouri Valley and that in southern Russia and in Turkestan and northern China are perfect; but in general distribution there is great diversity. In China the deposits occur in vast wind-blown masses near the summits of the mountain border on the east coast of Mongolia, up to five thousand feet above the sea. Elsewhere, however, only in the lower areas are they distributed over level areas, evidently by water action; while at the head of the plain extending west from Pekin, near the Nankau Pass, there are evident deltas six hundred feet above the sea, consisting of loess mingled with large transported blocks of rock.

Along the northern base of the Ala Tan Mountains in Turkestan, and along the western base of the Thian Shan Mountains, the delta-like characteristics of the distribution are evident, maintaining a pretty general level of twenty-five hundred feet above the sea.

Over the southern plains of Russia the deposit maintains a pretty general level of six hundred feet, having a scope of from fifty to a hundred feet over everything, though the rivers have cut channels three hundred feet in the more southern portions.

In the Missouri Valley there is also a definite relation to the streams. On both sides of the Missouri the deposit is developed from Yankton to Kansas City in almost equal degree, having a depth of a hundred feet or more.

Both in the Missouri Valley and in the lower levels in China there are also frequent indications of water action in more or less obscure lines of bedding, while in both areas, fossils are scarce, and mostly of land species which love moist places. In China the source of material is certainly not from a glaciated area, while in the Missouri Valley it is probably both from the adjacent glaciated area and from the arid plains to the west. In both areas the distribution by water is best accounted for on the theory of an extensive subsidence of land over the entire northern hemisphere. In the Missouri Valley the following order of earth movements seems best to fit the facts:

1. Preglacial elevation of two thousand or three thousand feet. This continued until the close of the Kansan stage.

2. Depression increasing toward the north until the level was considerably below present level. This closed the Iowan stage, and was accompanied by the main loess deposits, while the gradient of the river was reduced to a few inches per mile, and the water action increased from ten to twenty feet during the late summer melting of the ice, covering all the adjoining land for a few weeks, and then leaving it bare for the rest of the year. Thus the peculiar fossils may be accounted for.

3. An elevation increasing to the north with an east and west axis near the latitude of Omaha, culminating in the Wisconsin stage. The once waste grounds from the Wisconsin moraines down the Big Sioux River are a mile and a half wide, and only ten feet above the present flood plain. These continue for a little distance down the Missouri after reaching Omaha. Below Omaha there has been filling, instead of erosion, since the Wisconsin stage. This would give to the loess deposits undoubted Iowan age.

Prof. A. M. Miller, of the Kentucky State College, announced the discovery of a new meteorite in Kentucky, to which he has given the name of the "Bath Furnace" meteorite. This is an aerolite and it weighs 12 pounds 10½ ounces. Specific gravity, 3.48. The meteorite fell at 6:45 P. M., November 15, 1902, near Bath Furnace, Bath County, Ky., after making a brilliant display observed in the States of Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, and Ohio. The stone was picked up by Mr. Bluford Staten, an eyewitness of the fall, and is now in the possession of Prof. H. A. Ward.

"Science at the World's Fair, St. Louis, 1904," by J. A. Holmes, St. Louis, Mo. The exhibits at the approaching Universal Exposition to be held in St. Louis, from April 30 to December 1, 1904, will endeavor to show the applications of science in all the great industries of the country; and in some of these departments, notably that of mines and metallurgy, it is proposed to show the equipment and methods of geological surveys and similar institutions for geologic, geographic, and metallurgic research; in fisheries will be shown methods and equipment for biologic research; in liberal arts, laboratory research equipment in many branches of science; in education, equipment and methods of instruction and research at the institutions of learning; in the department of electricity will be shown modern equipment and methods of electrical research. In addition to the above, arrangements are being made for holding, under the auspices of the Exposition, a number of scientific congresses for the discussion of methods and equipment, and general plans for research, in all departments of knowledge.

"Basin-Range Structure in the Death Valley Region of Southeastern California," by M. R. Campbell. "Recently attention has been called to the geologic structure of the mountain ranges of Nevada and southeastern California. An attempt has been made to show that they are generally anticlinal in structure, and that the tilted-block type which Gilbert has described, and which is generally known as basin-range structure, is of rare occurrence. The object of the present paper is to show that, although minor folding was observed in the Death Valley region, the mountains are generally composed of huge blocks of strata that have been strongly tilted and then eroded into their present forms. The region described is traversed by two systems of structure; one extending in a north-south direction, being the southern extension of the true basin ranges of Nevada, and the other crossing these in a northwest-southeast direction parallel with and presumably an offshoot from the main line of the Sierra Nevada. The movements which produced these structures seem to have been preceded by an epoch of slight folding in which the Paleozoic strata were somewhat deformed. This was followed presumably in Eocene time by faulting and tilting along the northwest-southeast axes which formed parallel mountains and valleys trending in the same direction as the Sierra Nevada. In the valleys so formed lakes accumulated, probably through a change in climatic conditions, and sediments having a thickness of several thousand feet were laid down. In these lake beds are the great deposits of salt, gypsum, soda, and borax, which have made the region famous and of great economic importance. Following this period of sedimentation came one of movement along north-south axes, which lifted and tilted the surface into immense mountain ranges trending parallel with the new axes. Panamint, Death, and Amargosa valleys were thus formed, and Funeral and Panamint mountains were raised up between them. Lakes formed in the new valleys and received sediments similar to those of the preceding period. The age of the second lake-forming period is vaguely referred to late Tertiary. From structural and stratigraphic evidence the beds are younger than the lake sediments of Death Valley, and they are certainly older than the gravel deposits which mark the Pleistocene period in this region; therefore, they are provisionally classed as Miocene and younger."

The other papers on the programme, which lack of space prevents our reviewing, were:

H. H. Ami, The first Eparchæan formation; John E. Wolff, Cambrian and Precambrian of Hoosac Mountains, Mass.; Frederick B. Peck, Basal conglomerate in Lehigh and Northampton Counties, Penn.; Curtis F. Marbut, Sandstones of the Ozark region in Missouri; George L. Coolie, Ordovician rocks of the Bellefontaine, Penn., section; L. C. Glenn, Devonian and Carboniferous rocks of southwestern New York; Geo. I. Adams, Stratigraphic relations of the Red Beds to the Carboniferous and Permian in northern Texas; N. H. Darton, Comparison of stratigraphy of Big Horn Mountains, Black Hills and Rocky Mountain Front range; W. T. Lee, Age of the Atlantosaurus beds; W. B. Clark, Cretaceous-Eocene boundary in the Atlantic coastal plain; M. L. Fuller and F. G. Clapp, Marl-loess of the lower Wabash valley; Bailey Willis, Ames Knob, North Haven, Me.; W. C. Knight and J. F. Kemp, Geology of the Leucite Hills, Wyo.; Edward B. Mathews, Structural relations in the Piedmont area of northern Maryland; Amadeus W. Grabau, Geology of Becraft Mountain, N. Y.; Henry S. Williams, Shifting of faunas as a problem of stratigraphic geology; Amadeus W. Grabau, Palæozoic coral reefs, with notes on the classification of limestones; John C. Merriam, Primitive characters of the Triassic Ichthyosaurus; John M. Clarke, Distribution of Mastodon remains in New York; David White, Permian elements in the Dunkard flora; Joseph P. Iddings, Chemical composition of igneous rocks expressed by means of diagrams; Henry S. Washington, Quantitative distribution of rock magmas; George I. Finlay and J. F. Kemp, Nepheline syenite area of San José, Tamaulipas, Mexico; Alfred C. Lane, Studies in the grain of igneous intrusives; Alfred C. Lane, On the porphyritic appearance; B. K. Emerson, A plumose diabase containing sideromelan and spherulites of calcite and blue quartz; J. Morgan Clements, Spherulitic texture in Archean greenstones of Minnesota; F. P. Gulliver, Recent shoreline changes: Nantucket; Israel C. Russell, Lakes Malheur and Harney, Oregon; Israel C. Russell, Artesian wells near Enterprise, Idaho; Richard R. Hice, Direction of flow of the ancient Beaver river shown by pot-holes; W. M. Davis, Block mountains of the Basin Range province; G. K. Gilbert, Origin of Basin Ranges; J. E. Todd, Concretions and their geological effects; J. F. Newsom, Clastic dikes; H. Fielding Reid, Instruments for observation of disturbances caused by distant earthquakes; A. H. Elftman, Relation between the Keewatin and Laurentide ice sheets; A. H. Elftman, Postglacial time; E. R. Buckley, S. H. Ball, A. T. Smith, Glacial boulders along the Osage river in Missouri; H. L. Fairchild, Glacial drainage in central-western New York; J. M. Clarke, Current work in palæontology in New York State; O. P. Hay, On an important but not well known locality furnishing Cretaceous fishes; W. M. Davis, The freshwater Tertiaries at Green River, Wyoming; G. K. Gilbert, A highly viscous eruption of rhyolite; Ellen Hayes, Lunar calderas; W. H. Hobbs, Evidences of post-Newark normal faulting in the crystalline rocks of southwestern New England; and a record of post-Newark depression and subsequent elevation within the area of southwestern New England; C. R. Van Hise, The relations of metamorphism to the redistribution of the chemical elements; T. C. Chamberlin, Criteria requisite for the reference of relics to a glacial age; B. K. Emerson, Glacial cirques and rock-terraces on Mt. Toby, Mass; C. H. Hitchcock, Protection of terraces in the upper Connecticut River; Frank Leverett, Glacial features of Lower Michigan; J. E. Todd, Further notes on Lake Arickaree.

Mr. S. F. Emmons, of the United States Geological Survey, was elected president of the Geological Society of America, and Prof. H. L. Fairchild, of the University of Rochester, was re-elected secretary. Prof. Israel C. Russell, of the University of Michigan,

was elected vice-president and chairman of Section E, American Association for the Advancement of Science, and Dr. George B. Shattuck was elected secretary.

SOME CURIOUS AUSTRALIAN CAVES.

By JOHN PLUMMER.

AMONG the numerous minor cave systems found in New South Wales, none are more remarkable than those situated at Oakey Creek, in the heart of a country rich in mineral wealth, gold, silver, and tin being frequently found, also diamonds and other gemstones. All the streams in the neighborhood are more or less auriferous, and some of the oldest and richest goldfields in the State are to be found within a radius of a few miles. The caves are situated about a couple of miles from Cudgegong, a small but thriving rural village, surrounded by well-cultivated farms. The mineral richness of the district is proverbial, the whole of the country to the west being an immense goldfield, of which Hargraves, Windeyer and Tambaroora are the leading centers; while southward are Sofala, Hill End, Ophir, and other well-known gold-mining localities. Between Cudgegong and Rylstoe are some valuable cinnabar deposits. Copper, antimony and sulphur ores have been found at Oakey Creek, and large quantities of alum at Bocoble Creek, so called from Mount Bocoble, a remarkably shaped peak, forming one of the principal landmarks in the district. The Cudgegong River, on which the township is situated, is an auriferous stream, rising in Mount Benben, a peak of the Australian Alps, the country through which it flows being highly picturesque in places. The entrance to the caves is situated in a sequestered nook, and might be unsuspectingly passed by anyone not aware of its real character. How it was discovered has never been explained, but the first explorer must have been possessed of considerable nerve, for the opening is very small, only large enough to enable a moderately-sized person to crawl through, and when the visitor has safely accomplished this feat, he finds himself encircled by Cimmerian darkness. But directly a candle is lighted a wonderful transformation takes place, and a most enchanting scene, formed by multitudes of dainty, fantastically-shaped stalactites and stalagmites becomes revealed to view. The floor is one vast deposit of carbonate of lime, and from the roofs and sides of the calcareous cavity the same mineral hangs pendant in strange conglomerate shapes, that are sometimes artistic and sometimes grotesque. The visitor, unless forewarned, has not time enough to take in the beauties of these natural curiosities before he experiences a revulsion of horror at what is likely to make his flesh creep and his hair stand on end with apprehension of peril. No sooner does the light dispel the darkness than he is made aware of the presence of scores of bats, whose whirring flight is likely to make the unsophisticated conjure up ideas of hob-goblins and other denizens of spirit-land. Right at the entrance, too, is a solid white block, which has been formed from the constant drip of the limestone, and which, from its supernatural appearance and resemblance to the human form, has been christened "The Ghost." In this large cave there are four or five chambers, all similarly formed. In the main eastern one a dwarf fissure communicates with the upper crust, or *terra firma*, through which a tiny stream of light issues, which only serves to make the intense darkness a greater source of apprehension. The large cave leads to another, known as "The Blow Hole," the mysteries of which have never been penetrated. The entrance is by a crevice equal in size to the outer opening to the caves, but on throwing a stone in some seconds elapse before it is heard to strike bottom, a sufficient admonition to even the most venturesome of the abyss within, to explore which would be literally walking into the jaws of death. Those most familiar with the caves express an opinion that if the Blow Hole were properly explored another series of subterranean passages or chambers would be discovered. At present the caves are seldom visited, their existence being known to comparatively few outside the locality in which they are situated.

AUSTRALIAN SOFT WOODS.

THE heavy timbers in which Australia is so rich have become famous for their exceptional hardness and durability, but comparatively little is known outside the commonwealth of the numerous soft woods admirably adapted for the manufacture of furniture and for other industrial purposes. Such timbers are abundant in New South Wales, and are found principally in the immense brush forests of the coastal districts. Several of these timbers have a wood grained and marked most beautifully, and capable of receiving the highest polish, while others are fragrantly perfumed. Among the chief varieties of woods of this class may be mentioned the red cedar, the beautiful wood of which is admirably adapted for the finer kinds of cabinetmakers' work. Some of the cedar trees grow to an immense size, as much as 2,500 cubic feet of valuable timber having been obtained from one tree. In addition to the cedar may be mentioned tulipwood, yellowwood, white maple, myall, marblewood, mock orange, and many others. Besides their use for cabinetmaking, many of the brush timbers are of great utility for the rougher kinds of carpentry, while some, both hard and soft woods, are admirably adapted for coach builders' and coopers' work. The chief description of pine growing in New South Wales is the Moreton Bay white pine, found in the coast districts, as far south as the Bellinger. It is soft, light, and easily wrought, and suitable for all the interior woodwork of houses, as well as for cabinetmaking. The red or black pine is extensively distributed over the Liverpool Plains, and in the Lachlan and Darling River districts, as well as around Berrima. It is beautifully marked in the grain, takes a fine polish, and has an agreeable fragrance. There are numerous other varieties of pine, but these resemble in their main features the trees already described. Australian deal is an excellent timber, and is obtained in very large scantling, the tree frequently reaching 120 feet in height. It is soft, close-grained, easily wrought, and remarkably free from knots. Its use, therefore, is extensive for cabinetmakers' work and house fittings. The New South Wales Government Statistician mentions several of the more useful of the soft and fancy woods of the State. They include the beech, which attains a height of 100 to 150 feet, with a diameter of 3 to 5 feet, giving a strong, white, close-grained, and durable wood, easily worked, and greatly valued for decks of vessels, flooring, turnery and furniture making; the black bean, growing to a height of 120 to 130 feet, with a diameter of from 4 to 5 feet, with a handsome, close-grained, dark-colored, durable wood; the black oak, used for bullock yokes, tool handles, shingles, etc.; and the blackwood, resembling walnut, and highly valued for making furniture. Another valuable timber is the rosewood. It is strong-grained and durable, with a color resembling Spanish mahogany. Among other woods may be menticned the silky oak, which attains a height of 70 to 80 feet. The color is a light gray, beautifully crossed with silvery waves, and when polished the surface has a delicate luster. Bedroom suits made from this wood possess a dainty appearance. Satinwood is another useful timber, yellow in color. It is soft and silky to the touch, close-grained, and easily wrought. This wood is also suitable for cabinetmaking, and is considered to be superior to the satinwood used in the European and American furniture trade. When the system of forest conservation becomes more general in the State, the supplies of many of the timbers mentioned will become practically inexhaustible, and are certain to be in large demand for export purposes.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Advice to Exporters to Scotland.—In a letter to the Philadelphia Museums (the original has been forwarded) Consul Rufus Fleming, of Edinburgh, gives the following information:

Commercial Travelers.—The question of chief importance to our manufacturers is how to introduce or extend the sale of a special article or special line of articles—whether to place it wholly in the hands of local agents or to send men to work up trade. The difference between American and Scottish business methods is a matter of common knowledge to all our exporters; it is a difference of temperament and of customs. We are in the habit of "pushing trade," and are not satisfied with slow returns. If I were asked whether, in my opinion, an American is a better seller of American goods in Scotland than a Scotsman, I should answer in the affirmative, but with the qualification that the American salesman must have the tact to adapt himself rigidly to the business ways and social customs of the country. Enterprise counts, if wisely directed, and if there is back of it a good-humored patience and a thorough respect for the ideas and methods of the commercial community in Scotland. The foreign salesman who becomes a critic is a failure. He can sell nothing. I had a talk on this subject recently with an American agent of an American manufacturing concern who has had more than a year's experience in England and Scotland, and, I may add, has been very successful during the past six months. He said:

"My company entered this field about two years ago, establishing a general agency in London with an American in charge, and sending across a dozen salesmen, some of whom had done excellent work in our country as commercial travelers. Only three of these men were here at the end of the year. Nine had not earned their salt, and were recalled. The trouble was with the men—not with the machine which they were introducing. None of us had been in Great Britain before and we knew little about business customs on this side, and less in regard to the characteristics of the people. During the first three months, I frankly confess, I pursued a foolish course. I had adopted the wrong attitude at the start in assuming that I knew better than the merchants and shopkeepers what were their requirements and how to conduct their businesses. Finally, it dawned upon me that I was not here to change the commercial methods but to sell machines, and that the only way to do business was to accept conditions as they were and to get into harmony with them. From that day, I have been successful. All my early ideas about business men and methods in Scotland have undergone a radical change. Not only the wholesale merchants but also the shopkeepers are, as a rule, remarkably clear-headed men, with a perfect knowledge of their own affairs and interests; always ready to spend money in order to make money, and each relying absolutely upon his own judgment as to the merits of any article brought to his attention."

Within the limitations which I have indicated, the enterprise of American commercial travelers or agents and of those of the Continent, notably Germans and Russians, is effective. I need not go into details as to what methods are specially useful. They are the methods common in our country. For example, the American agent of a computing scale company began business in a Scotch city by going to all the principal grocers and butchers, making a purchase at each shop, taking a memorandum in each instance of the weight and cost. Afterward, when he invited them to come to his place of business and see the computing scale, the agent was able to show each exactly what he had lost in that small transaction. All legitimate plans of selling machines or goods can be as effectively applied here as in America or elsewhere, by one who fully understands the national or racial temperament.

Labor-Saving Machinery.—American manufacturers are aware of the hostility of British workmen to labor-saving machinery. Some of our makers of machinery have had experience of this antagonism in British shops to any new devices for increasing the output without increasing the labor cost, and they have learned to expect that their machines sold in England or Scotland must at first undergo a severe test at the hands of unfriendly operators. I have in mind the case of a Scotch sawmiller who purchased in America an improved device for one branch of his business, which was guaranteed to do one-third more work than the apparatus he had long been using, without any additional labor cost. For some weeks after the machine was installed, there was no greater output. He questioned his workmen and watched them, but could discover no delinquency on their part. Confident, however, that they were not giving the machine a fair trial—he had seen it operate in America and knew what it would do under favorable conditions—he resolved to get at the difficulty, and, giving the men a holiday one Saturday, he went to the mill with his superintendent, and they operated the machine with far better results than had been obtained by the workmen—in a word, it did exactly what the makers had said it would do. On Monday morning, the sawmiller told his men that if they wished to continue in his employ they must turn out a certain amount of work per hour with the new machine. He had no reason thereafter to find fault with either the machine or the men. This incident is one of the many that might be related, showing that our manufacturers of labor-saving apparatus must always have in view, when selling to new customers on this side, the probability that their machines will not receive friendly or fair treatment from workmen at the start.

Notes.—On the general subject of the development of our trade here, I present a few observations, which are intended as suggestions:

1. Scotsmen have a decided preference for British-made goods, if equal in quality and not markedly higher in prices than foreign competing articles. To sell foreign competing goods in Scotland, it is necessary, as a rule, to offer a superior grade at the prevailing prices, or standard goods at prices below the quotations for the home articles. American goods are preferred to any other foreign products.

2. In the case of a novelty or a non-competing article greatly superior, price is a secondary consideration with the average Scotsman. If he wants it, he will buy it, provided the price is within reason.

3. In offering machinery of any kind here, it is a mistake to make extravagant claims as to what it will do. A moderate statement of its advantages is far more likely to lead to a sale.

4. Merchants and manufacturers wish to deal with a duly commissioned and responsible representative of the firm or company seeking to do business with them—an agent authorized to make a definite and binding contract.

5. In almost all lines of trade, c. i. f. quotations are required.

6. In every pound of promise a Scotsman expects to find sixteen ounces of performance.

Demand for American Machinery at Quito.—Under date of December 1, 1902, Minister Sampson, of Quito, writes that a company is being formed in that city to build a large cotton mill. The preference is for American machinery and looms, and the request is made that firms interested, particularly the Northup Loom Company, send as soon as possible their catalogues and price lists to Minister Sampson, care of the State Department, Washington. European agents are already bidding for the contract, which will not be let until American catalogues and price lists have been received.

Opening for Sulphate of Copper in Greece.—I have just sent a telegram * announcing the decision of the Currant Bank to purchase sulphate of copper to the extent of 1,000 tons for immediate shipment.

The conditions governing bids are the same as those of last year, particulars of which were printed in Consular Reports No. 258 (March, 1902).† The bids will be opened January 22, and the successful company must place the cargo in this port on or before the 28th of February.

The success of the American syndicate last year—for the first time, I believe, in the copper-sulphate trade of this country when our product was brought into direct competition with the European—presupposes a favorable issue a second time. However, European firms which have succeeded for many seasons in placing their product on this market at high prices were enlightened, though not pleased, by the American invasion of last year, and their representatives here are prepared to nip this invasion in its infancy. The order which the Current Bank expects to place has double the value of its last year's opening order, and is certainly worth three times last year's effort to secure.—Frank W. Jackson, Consul at Patras.

Cheap Household Disinfectant.—Fendler (Gazette des Hôpitaux) has recently recommended the following as a powerful and cheap domestic disinfectant, which may be employed with advantage instead of more costly proprietary preparations: Tar oil, 20; sulphuric acid (90 per cent), 30; water, q. s. Heat the tar oil with the acid and cautiously add sufficient water to produce 100 parts. The product is a brown liquid with a phenol odor, which mixes bright, or nearly so, with water, in all proportions.—Nat. Drug.

* Printed in Advance Sheets No. 1525 (December 20, 1902).
† Advance Sheets No. 1264.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1548. January 19.—Metric Weights and Measures in Germany.

No. 1549. January 20.—Water Power in France—Repairing Aerial Wires by Automobile in France.

No. 1550. January 21.—Salt Mines of Ilezk, Russia—Textile Industry of St. Etienne—Silkworms in Italy—Siberian Copper—Dominican Customs Revenue—Leases of Rubber Land in Peru.

No. 1551. January 22.—Our Foreign Commerce in 1902.

No. 1552. January 23.—Railway Construction in Africa—*Opening for Sulphate of Copper in Greece—Preparation of Zacaton in Mexico—Meat Products in Paraguay—Russian Exhibition of Historical Attire—Exhibit of Photography at St. Petersburg.

No. 1553. January 24.—French Automobile Exposition—Amherstburg-Windsor Electric Road—Blockade of Venezuelan Ports.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

Ordinary Sealing Wax for Packing Purposes.—C. Fleck gives the following recipe for such a sealing wax, which will stick to smooth paper:

Brown shellac	25 parts.
Brown rosin	75 parts.
Ordinary turpentine	50 parts.
Brick dust	10 parts.
Bole	10 parts.
Red lead	20 parts.
Crude fish glue, as much as is necessary to bind the filling and dyestuffs.	

To avoid decreasing the adhesive qualities of the gums by excessive heating, the gums are powdered before the melting. If the turpentine and fish glue should contain pieces of wood or other impurities, they should be heated and filtered through linen or pieces of gauze laid together.

The hot fish glue is ground with the powdered filling agents and dyestuffs, and added by portions to the liquid gum mass, stirring constantly.

The following mistakes are sometimes made in the manufacture of sealing wax:

1. Use of filling agents which are too coarsely ground.
2. Excessive use of filling agents.
3. Insufficient binding of the pigments and fillings with a suitable adhesive agent, which causes these bodies to absorb the adhesive power of the gums.
4. Excessive heating of the mass, caused by improper melting or faulty admixture of the gummy bodies. Turpentine and rosin must be heated before entering the shellac. If this rule is inverted, as is often the case, the shellac sticks to the bottom and burns partly.—Papier Zeitung.

To Recover Tin from Galvanized Sheet Iron, Etc.—According to a Swedish patent recently granted, the tinned iron is placed in a receptacle whose walls consist of a stronger electro-positive metal than the tin, for instance iron. The receptacle is filled with caustic alkali, a depolarizer, as for example cupric oxide, being also provided. The result will be an electric current while at the same time the tin separates in the shape of alkali stannate. As soon as the alkali lye is saturated with alkali stannate, a current of carbonic acid is injected into the solution. This causes the tin to separate in the form of stannic hydrate, which is treated with acid, tin being finally obtained in metallic form from the resulting solution, by electrolysis.—Neueste Erfindungen und Erfahrungen.

The Safest Remedy for Chapped Hands consists, according to the Pharmaceutische Zeitung, of Berlin, in keeping the hands scrupulously dry and greasing them once in a while with an anhydrous fatty substance (not cold cream). Best adapted for this purpose is wax salve (olive oil 7 parts and yellow wax 3 parts) or pure olive oil.

Roof Varnishes, Red, Gray and Green.—In an ordinary iron kettle melt, over the naked fire, American rosin F 190 kilos, and gradually add coal tar oil or so-called anthracene oil 100 kilos. Now extinguish the fire under the receptacle and carefully add crude benzol (varnish benzine) 60 kilos, and stir all thoroughly again. When this is done gradually introduce 200 kilos of common bole, in portions of about 20 kilos, while one man keeps on stirring the mass diligently. The varnish is left to remain in the vessel for a while, and then gradually entered, warm, through a sieve into the barrels in which it is shipped. If desired to produce a cheaper article, the benzol may be omitted and a like quantity of additional tar oil used in its place, but in that case the varnish does not dry so quickly, and does not keep the gloss as well. In the preparation attention must be paid that the mass is thoroughly stirred whenever new ingredients are added. The production of gray and green roof varnish is same as above, with the exception that instead of bole, metallic gray and metallic green are employed respectively.

Stone Varnish.—Melt together coal tar pitch 150 kilos and American rosin F 50 kilos, and after removing the fire from under the kettle, add crude benzol 200 kilos, stirring constantly. For cheapening purposes 50 kilos of coal-tar oil might be added, deducting this quantity from the benzol, but admixtures of tar oil or tar alone are not suitable in the case of stone varnish.

Iron Varnish, Red.—Melt together in an iron kettle, over the naked fire, American rosin F 150 kilos and coal-tar pitch 25 kilos, and after removing the fire stir in crude benzol 200 kilos. Next enter with constant stirring iron minium, and otherwise proceed as explained for roof varnish. If desired, bole may be substituted for one-third of the quantity of iron minium.—Oesterreichische Farben und Lack Zeitung.

Recipes for Carbolineum.—Pale.—Melt together in an iron kettle, over a naked fire, 30 kilos of American rosin F and 150 kilos of pale paraffine oil and stir in 10 kilos of single rectified rosin oil.

Dark.—Melt 100 kilos of anthracene oil and 20 kilos of American rosin F on a slow fire. Next stir in 2 kilos of Para rubber solution (or solution of caoutchouc waste) and keep on boiling until all is dissolved. When this is done, there should be still added 5 kilos of crude concentrated carbolic acid and 5 kilos of zinc chloride lye, 50 deg. Bé, stirring until cool. The last-named admixture is not absolutely necessary, but highly advisable owing to its extraordinary preservative and bactericidal properties.

Colored.—For such, the mode of production is as follows: For red, melt 100 kilos of coal-tar oil, then stir in 50 kilos of pale paraffine oil, and finally 75 kilos of bole or iron minium, and pass through the paint mill. Although the addition of iron minium is, of course, very desirable, it is considerably more expensive. For gray, proceed same as above, with the exception that metallic gray is used in place of the bole. For green, metallic green is employed. The colors are identical with those used in the manufacture of roof varnish. To increase the antiseptic properties of the colored carbolineum, any desired additions of phenol or zinc chloride solutions may be made, but the chief requirement in the case of colored carbolineum is good covering power of the coating.—Oesterreichische Farben und Lack Zeitung.

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